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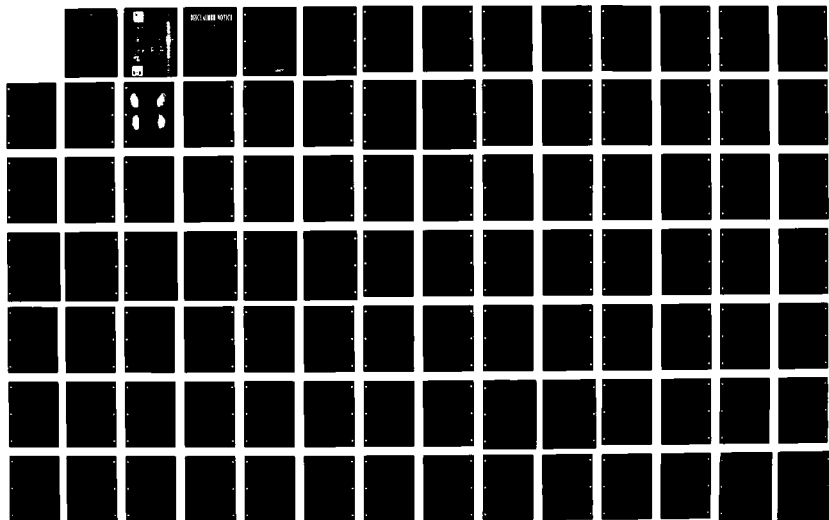
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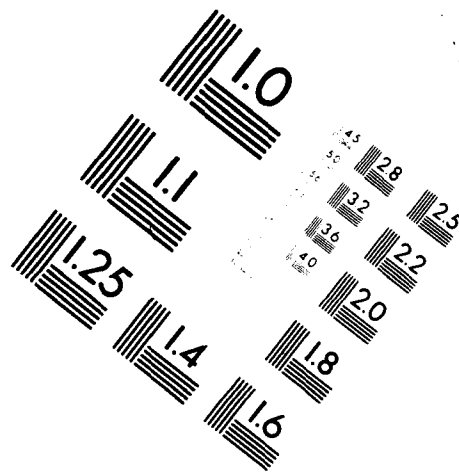
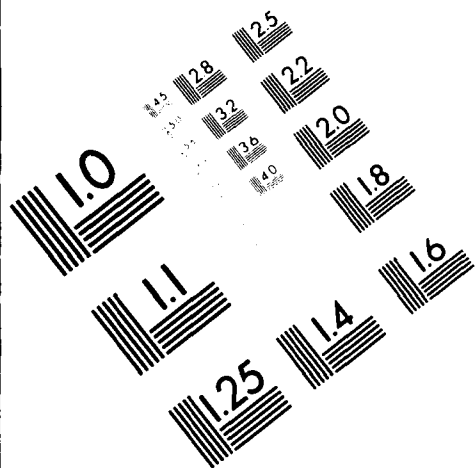


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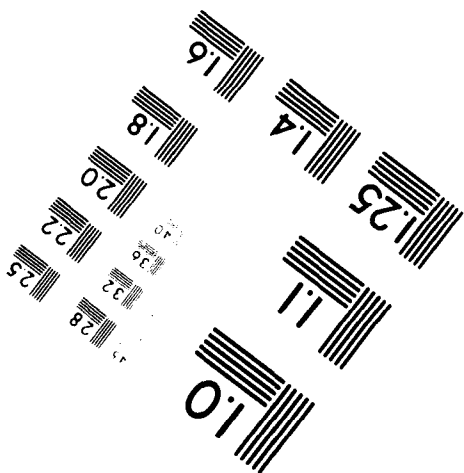
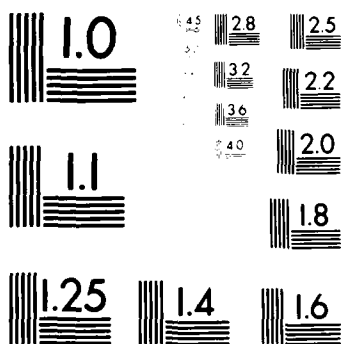
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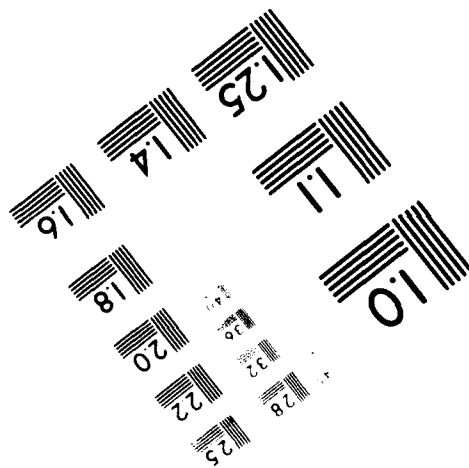
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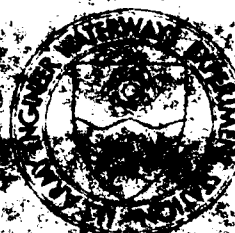
SELECT: A NUMERICAL
ONE-DIMENSIONAL MODEL FOR
SELECTIVE WITHDRAWAL

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Hydraulics Laboratory

DEPARTMENT OF THE ARMY
Waterways Experiment Station, Corps of Engineers
PO Box 631, Vicksburg, Mississippi 39180-0631

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Final Report

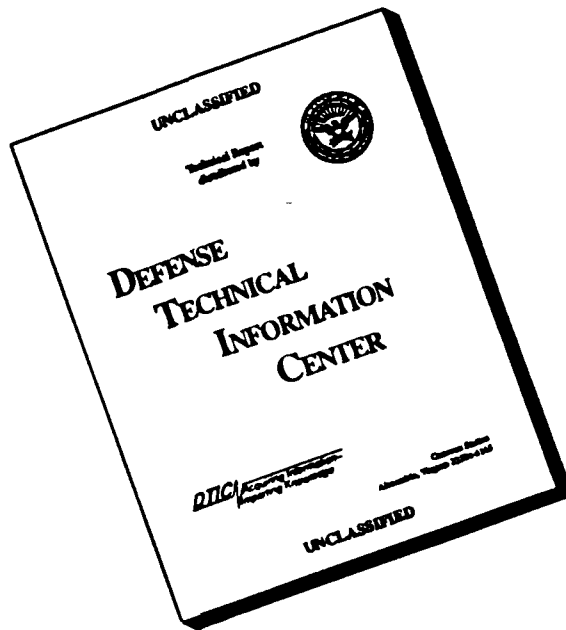
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SELECT: A NUMERICAL, ONE-DIMENSIONAL MODEL
FOR SELECTIVE WITHDRAWAL

Final Report
Instruction Report E-87-2
March 1987

Instructions for Updating the SELECT Program
and Its Documentation

1. Several improvements have been made and small errors corrected since the 1987 release of Version (Ver.) 1.0 of the SELECT program and documentation. The latest form of the program including these changes has been labelled Ver. 1.3. Ver. 1.1 and 1.2 were interim working versions of the program and therefore were not released or documented.

2. Documentation for Ver. 1.0 is found in the US Army Engineer Waterways Experiment Station Instruction Report E-87-2, entitled "SELECT: A Numerical One-Dimensional Model for Selective Withdrawal." To update this SELECT manual and make it current with the new program, you must

- a. Replace pages 13-14, 35-40, 71-72, and 89-94 in the main text with the corresponding pages in this enclosure.
- b. Replace Appendices A through E with their updated counterparts enclosed.

3. To update the program, a wholesale substitution should be made. That is, SELECT.FOR should be replaced with SELECT13.FOR, and SELECT.EXE with SELECT13.EXE. Input data files used with Ver. 1.0 should be compatible with Ver. 1.3 with one exception. Version 1.3 no longer expects to find the FILES command line in the input. The file assignments have been established as unit 05 for input and unit 06 for output. Removing the FILES command line from the Ver. 1.0 input files will make them usable with Ver. 1.3.

4. The programming errors corrected since Ver. 1.0 will not produce significantly different results for most SELECT applications. If an application you are running yields notably different answers with Ver. 1.3 than with Ver. 1.0, please contact us. A more detailed listing of the changes is given as comment within the code and appears on page 1 of Appendix E of the enclosure.

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Instruction Report E-87-2
July 1992

5. If placed in the manual, these pages can serve as an indication that the manual has been updated and when and how it was done. Any questions or comments regarding this update should be directed to either Mr. Stacy E. Howington (601-634-2939) or Mr. Steven C. Wilhelms (601-634-2475).

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| 19 ABSTRACT (Continue on reverse if necessary and identify by block number) This report was developed to aid users of the program SELECT. It provides guidance on how to construct an input file and how to interpret the output file. It also overviews the concepts behind the program and the internal methodology of its execution. Examples of input and output are also provided. | | | | | |
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PREFACE

Development of this report was sponsored by the Office, Chief of Engineers (OCE), US Army, as a part of the Environmental and Water Quality Operational Studies (EWQOS) Program, Work Unit IIIA.4 (CWIS Work Unit 31604), entitled "Techniques to Meet Environmental Quality Objectives for Reservoir Releases." The OCE Technical Monitors of the EWQOS Program were Mr. Earl E. Eiker, Dr. John Bushman, and Mr. James L. Gottesman. Program Manager of EWQOS was Dr. J. L. Mahloch.

This report was prepared by the Hydraulics Laboratory (HL), US Army Engineer Waterways Experiment Station (WES), under the general supervision of Mr. F. A. Herrmann, Jr., Chief of the HL; Mr. H. B. Simmons, former Chief of the HL; and Mr. John L. Grace, Jr., Chief of the Hydraulic Structures Division; and under the direct supervision of Mr. Jeffery P. Holland, Chief of the Reservoir Water Quality Branch. The report was written by Messrs. Jack E. Davis, Jeffery P. Holland, Michael L. Schneider, and Steven C. Wilhelms. Messrs. Terry Reeves and James A. Daub contributed in the preparation of the variable lists and Appendix A. The report was prepared for publication by Ms. Jessica S. Ruff of the WES Information Products Division of the Information Technology Laboratory.

COL Allen F. Grum, USA, was the previous Director of WES. COL Dwayne G. Lee, CE, is the present Commander and Director. Dr. Robert W. Whalin is Technical Director.

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CONTENTS

| | <u>Page</u> |
|---|-------------|
| PREFACE..... | 1 |
| PART I: INTRODUCTION..... | 4 |
| Background..... | 4 |
| Purpose and Scope..... | 5 |
| PART II: AN OVERVIEW OF SELECT AND ITS USE..... | 6 |
| Program Purpose..... | 6 |
| Conceptual Methodology..... | 7 |
| Overview of Program Execution..... | 8 |
| Available Assistance..... | 13 |
| PART III: PROGRAM DESCRIPTION..... | 14 |
| Main Program..... | 14 |
| DENINT..... | 17 |
| INTERP..... | 23 |
| OUTVEL..... | 28 |
| VPORT..... | 34 |
| VWEIR..... | 50 |
| SHIFT..... | 59 |
| XPRINT..... | 67 |
| DVPLLOT..... | 71 |
| ERROR..... | 75 |
| XREAD..... | 77 |
| AERATE..... | 83 |
| VENTING..... | 85 |
| PART IV: ASSUMPTIONS AND LIMITATIONS..... | 87 |
| Geometry of Ports..... | 87 |
| Impoundment Width..... | 87 |
| Approach Path..... | 88 |
| Approach Curvature..... | 88 |
| Multiple Horizontal Ports..... | 88 |
| Weir Crest Above Thermocline..... | 89 |
| Hydraulic Integrity..... | 89 |
| Simultaneous Port-Weir Operation..... | 89 |
| PART V: INPUT DATA..... | 90 |
| Descriptions..... | 90 |
| Profile Formats..... | 93 |
| REFERENCES..... | 94 |
| APPENDIX A: INPUT FORMAT DESCRIPTION..... | A1 |
| Notes on Input Format..... | A1 |
| SELECT Program-Input Format Description..... | A2 |

| | <u>Page</u> |
|--------------------------------------|-------------|
| APPENDIX B: INPUT FILE EXAMPLES..... | B1 |
| Example File 1..... | B1 |
| Example File 2..... | B2 |
| Example File 3..... | B3 |
| Example File 4..... | B4 |
| APPENDIX C: OUTPUT EXAMPLE..... | C1 |
| APPENDIX D: ERROR CODES..... | D1 |
| APPENDIX E: PROGRAM CODE..... | E1 |

SELECT: A NUMERICAL, ONE-DIMENSIONAL MODEL
FOR SELECTIVE WITHDRAWAL

PART I: INTRODUCTION

Background

1. As a result of increased public awareness and state and Federal legislation, Corps of Engineers (CE) water resources projects are being operated with an emphasis on water quality considerations. The use of a reservoir outlet works incorporating fixed or multilevel selective withdrawal structures is a primary method for the control of reservoir release quality. These structures release water from specified strata in a density-stratified reservoir, thereby allowing, through blending of flows or direct release, greater control of water quality. Two general conditions must be met to ensure that a given structure has the ability to selectively withdraw reservoir waters. First, if the structure exists, the outlets must be at appropriate elevations and have sufficient capacity such that particular outlets can be operated to withdraw water of a desired quality. If the structure is proposed, the number, locations, and capacities of outlets should be determined as part of the design procedure to ensure that the required level of release water can be maintained. Second, for efficient operation of an existing structure or optimal design of a proposed structure, the operator or designer must have the capability to describe the zone of withdrawal formed by a discharge through a selective withdrawal outlet for a given outlet geometry, location, and discharge. Additionally, proper hydraulic performance of such structures acts as a constraint for any solution.

2. Research at the US Army Engineer Waterways Experiment Station (WES) has provided extensive technology with which to assist the operator or designer in addressing the conditions listed above. Through laboratory experimentation, Bohan and Grace (1969) and Grace (1971)

described the withdrawal zone formed by releases from a density-stratified reservoir through ports (orifice flow) and over weirs (i.e., spillway flow, thermal berms). An outgrowth of this initial research was the development of the one-dimensional computer program SELECT, which computes the withdrawal zone formed by a given release through or over a specified outlet structure for a known reservoir density stratification. The program also computes the quality characteristics of the release for user-specified parameters (temperature, dissolved oxygen, etc.) treated as conservative substances. Additional work, which includes Dortch and Holland (1984), describes a numerical procedure that systematically evaluates the optimal number and locations of selective withdrawal intakes required to meet a specified release quality objective. Holland (1984) also overviews the steps that must be followed in the design of selective withdrawal structures.

3. Recent research efforts, building on the work of Bohan and Grace (1973) and many other researchers, have resulted in more-generalized techniques for the description of the withdrawal zone formed by a reservoir release through a port acting as a point sink. Smith et al. (1987) document these techniques. Subsequently, the results of these and other research efforts have been incorporated into an update of the SELECT program.

Purpose and Scope

4. The purpose of this report is to document the updated version of the SELECT program for field office use. This will be done by describing the computational methodologies and the sequence of operations in SELECT (Part II), the operations used in the subprograms (Part III), and the assumptions and limitations inherent to the code (Part IV). Definitions of the data required as input are provided in Part V. Additional information presented in the report includes a description of the input format (Appendix A), input file and output examples (Appendixes B and C), error codes (Appendix D), and program code (Appendix E).

PART II: AN OVERVIEW OF SELECT AND ITS USE

Program Purpose

5. The SELECT program is a one-dimensional numerical model that predicts the vertical extent and distribution of withdrawal from a reservoir of known density and quality distribution for a given discharge from a specified location. Using this prediction for the withdrawal zone, SELECT computes the quality of the release for user-specified parameters (such as temperature, dissolved oxygen (DO), turbidity, iron) treated as conservative substances. The release constituents are considered conservative through the selective withdrawal structure because the detention time in the structure is short compared with the time required for the constituents to physically or chemically change. For example, there would be no time for the water temperature to change significantly nor would there be time for iron to oxidize significantly. SELECT will predict, however, the improvement in DO that would occur due either to natural reaeration, as flow passes through gated-conduit outlet works, or to turbine venting.

6. It is important for the user to realize the purpose of SELECT. SELECT was developed based on the philosophy that the field office users require a tool to compute the withdrawal and release quality characteristics of a structure for given values of density stratification, outlet geometry, and discharge. SELECT is that tool. SELECT is not a water quality or thermal simulation model. It does not consider all the hydrodynamic and biochemical processes ongoing in a reservoir. Its purpose is to compute withdrawal and release quality characteristics.

7. Many times the computation of reservoir release characteristics is, within itself, sufficient to provide insight into the solutions to the posed problems. For example, the day-to-day operation of a multilevel outlet works or the initial design of a thermal berm could be performed with SELECT.

Conceptual Methodology

8. SELECT accomplishes its assigned tasks, subject to various assumptions and limitations, by first dividing the reservoir pool into a user-specified number of layers of equal thickness. (The user should first note the program assumptions and limitations outlined in Part IV.) The layers are assumed in the code to be longitudinally and laterally homogeneous in quality. The effects of density stratification are assumed to act only in the vertical dimension on the release from the project. The velocities induced by the release are also assumed to vary only in the vertical direction, in keeping with the one-dimensional assumption of the program.

9. SELECT computes the limits of withdrawal (defined as the vertical locations in the pool beyond which there is no contribution to the total release), the vertical distribution of withdrawal between those limits, the point of maximum withdrawal, and the outflow quality characteristics. To do this, SELECT first computes a normalized velocity profile for the region within the withdrawal zone of each port or weir. This profile is normalized in the sense that the individual point velocities are divided by the maximum profile velocity and subsequently scaled such that their integration over the profile would yield the discharge producing them.

10. The purpose of computing the normalized velocity profile is not to provide a prediction of actual velocities in the reservoir; rather, the normalized velocity profile is used to generate the reservoir withdrawal profile as a final product. The individual withdrawal profiles from each outlet are then summed, yielding a total withdrawal profile with corresponding withdrawal limits. With the total withdrawal profile known, the release quality can be determined by weighting the quality contribution of each layer with respect to the ratio of the layer discharge to the total discharge.

11. The user should also be alerted to the phrase "theoretical limit of withdrawal" used in this report. This phrase is used to denote a withdrawal condition for which the potential to withdraw flow from

much higher or lower in the pool would have existed had the withdrawal zone not been truncated by the physical boundaries of the reservoir, e.g., the water surface or bottom, respectively. The theoretical limit stands in contrast to the physical limit taken to be the water surface or bottom.

12. A final concept must be formalized prior to use of the model. SELECT uses the concept of "withdrawal angle" to incorporate the effects of many local topographical conditions upon port withdrawal zone formation. In plan view, the withdrawal angle can be thought of as the angle the outlet works structure makes with the local topography. The plan views in Figures 1a and 1b show effective withdrawal angles of π (180 deg) and $\pi/2$ (90 deg), respectively. These conditions typify the most common means of withdrawal through an outlet tower in the middle of a dam face and at the edge of a dam face near a wall.

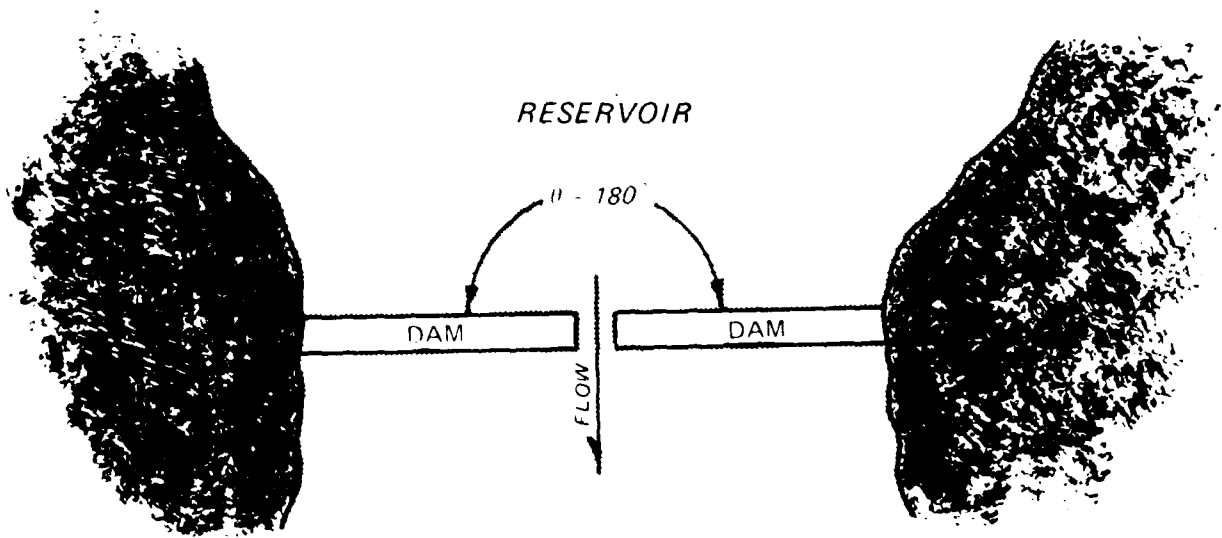
13. SELECT incorporates the concepts described above in a set of transcendental equations that must be iteratively solved to obtain the withdrawal zone characteristics.

Overview of Program Execution

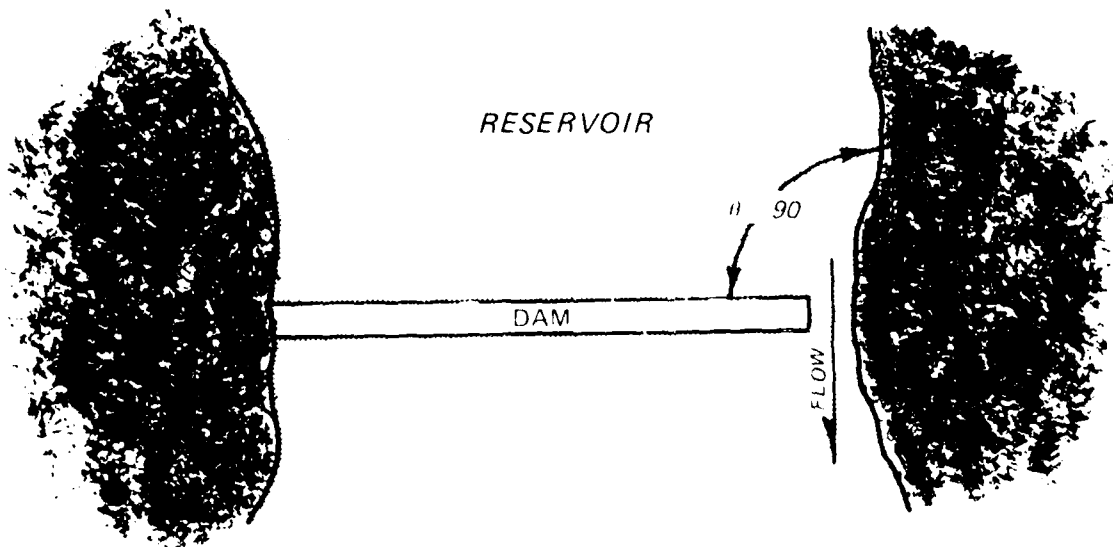
14. The following paragraphs outline the sequence of operations that SELECT executes to determine the withdrawal limits and release water quality. Figure 2 is a flowchart that depicts this sequence. The branches at decision points in the flowchart are labeled T and F for true or false. Figure 3 gives the program call sequence from each subprogram.

15. SELECT's main program orders the sequence in which the subprograms are executed. Subroutine XREAD is called first by the main program to read information from the input file concerning program control parameters such as the number of data sets in the input file. XREAD is then called again to read information about the impoundment, the outlets, and the vertical distribution of all water quality parameters being modeled.

16. After each water quality parameter distribution is entered,



a. Withdrawal angle, 180 deg



b. Withdrawal angle, 90 deg

Figure 1. Plan view of reservoirs showing 180- and 90-deg withdrawal angles (θ)

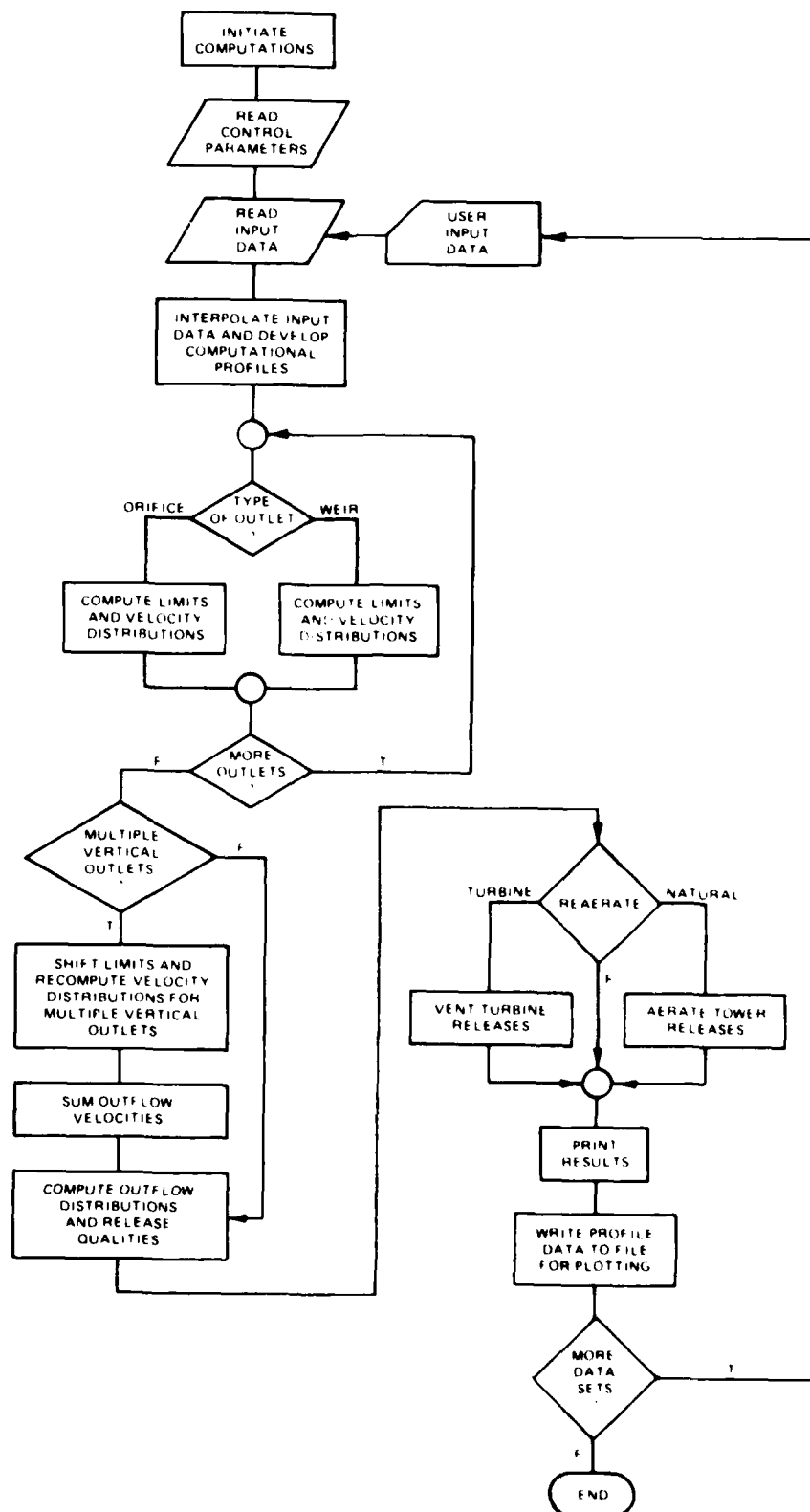


Figure 2. SELECT flowchart

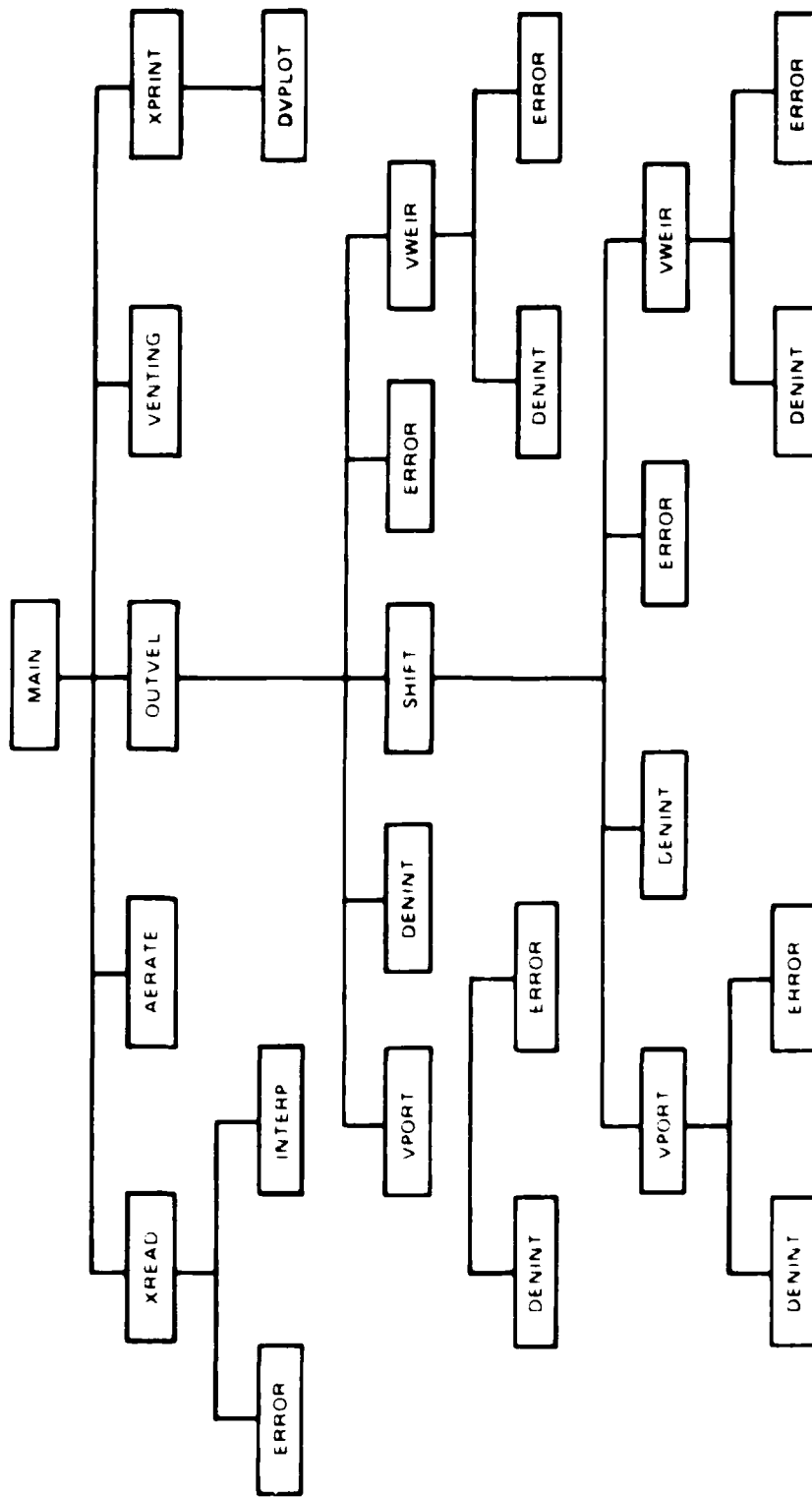


Figure 3. The branched system illustrates the call sequence from each subprogram

subroutine INTERP interpolates between input parameter values at their respective elevations to produce values at the center lines of evenly spaced and vertically distributed horizontal layers (see subroutine INTERP description for greater detail on horizontal layers). Vertical distributions for each parameter are thus created for computational purposes. SELECT bases all of its calculations on these distributions.

17. Subroutine OUTVEL is the next to be called in SELECT's execution. OUTVEL is a subprogram that carries out the organizational duties of the computational portion of the program. Based on whether a weir or a port is being modeled, OUTVEL calls subroutine VWEIR or VPORT, respectively, which are the main computational subroutines in SELECT. VWEIR and VPORT generate the withdrawal zone limits and compute the discharges or flow rates from each computational layer within the withdrawal zone. Program control is then moved back to OUTVEL where all of the withdrawal zone discharges for each outlet modeled in VPORT and VWEIR are summed. The subroutine then normalizes the withdrawal distribution, effectively creating the total normalized velocity distribution. OUTVEL then determines the total release water quality parameter values by summing the contributions of each layer for each parameter modeled. To compute these release values, OUTVEL assumes that each parameter acts as a conservative constituent during the withdrawal process, since detention time in the structure during the release is small compared with the time required for the constituents to change physically or chemically.

18. If withdrawal zones from different outlets overlap vertically, OUTVEL calls subroutine SHIFT to adjust the withdrawal zone limits and outflow profiles from each overlapping zone before the zones are summed as previously stated.

19. If adjustments to the DO content of the release flow are desired based on aeration of the release by the outlet structure (due to turbine venting or natural structural reaeration processes, as described in paragraphs 5-7), the adjustments are performed just prior to outputting the final results.

20. The results are output by subroutines XPRINT and PLOT. A plot of the normalized velocity and density distribution is generated by

DV PLOT, and a tabular listing of profile data such as DO, normalized velocity, withdrawal, temperature, and other quality constituents is generated by XPRINT along with information about the outlet characteristics and withdrawal zone limits. Details of each of these subprograms are given in Part III.

Available Assistance

21. Assistance in understanding, setting up, or executing the SELECT program or in analyzing its results is available to CE Field Operating Agency users. Copies of the SELECT code are available for use on most mainframes, minicomputers, workstations, and personal computers. Thus far, the program has been executed on Control Data Corporation and CRAY mainframes; Digital Equipment Corporation (DEC) VAX minicomputers and workstations; and IBM, DEC, and Dell personal computers.

PART III: PROGRAM DESCRIPTION

22. The following sections give detailed descriptions of the equations and logic in SELECT and its subprograms. A written description of each subprogram is given along with a flowchart diagramming the operational sequence of the subprogram. Note that throughout the report, T and F signify true and false at decision points in the given flowcharts. Listings of the variables in each subprogram and their definitions are also given.

Main Program

23. The main program of SELECT is very small, with the bulk of the program being found in the functions and subroutines. The main program basically orders the calling sequence of the subprograms to perform input operations, calculations, and output operations (Figure 4). Table 1 lists the variables used in the main program.

24. The main program also performs other tasks that are very important to the operation of SELECT. The first is the generation of a density profile based on a user-input temperature profile. Generally, the user does not have density profile information on the impoundment being modeled but does have temperature data. SELECT will use an input temperature profile to generate densities for each discrete layer. The equation used to convert temperature to density is

$$\rho_1 = 1 - \frac{(T_1 - 3.9863)^2}{508.929.2} \cdot \frac{(T_1 - 288.9414)}{(T_1 - 68.12963)} \quad (1)$$

where

ρ_1 = density in grams per cubic centimeter for layer 1

T_1 = temperature in degrees Centigrade for layer 1

I = index designating a specified layer

The main program also checks the stability of the density profile that was given or generated. The profile is stable if the density never decreases with increasing depth. If the profile is found unstable, the program will terminate execution and issue an error message.

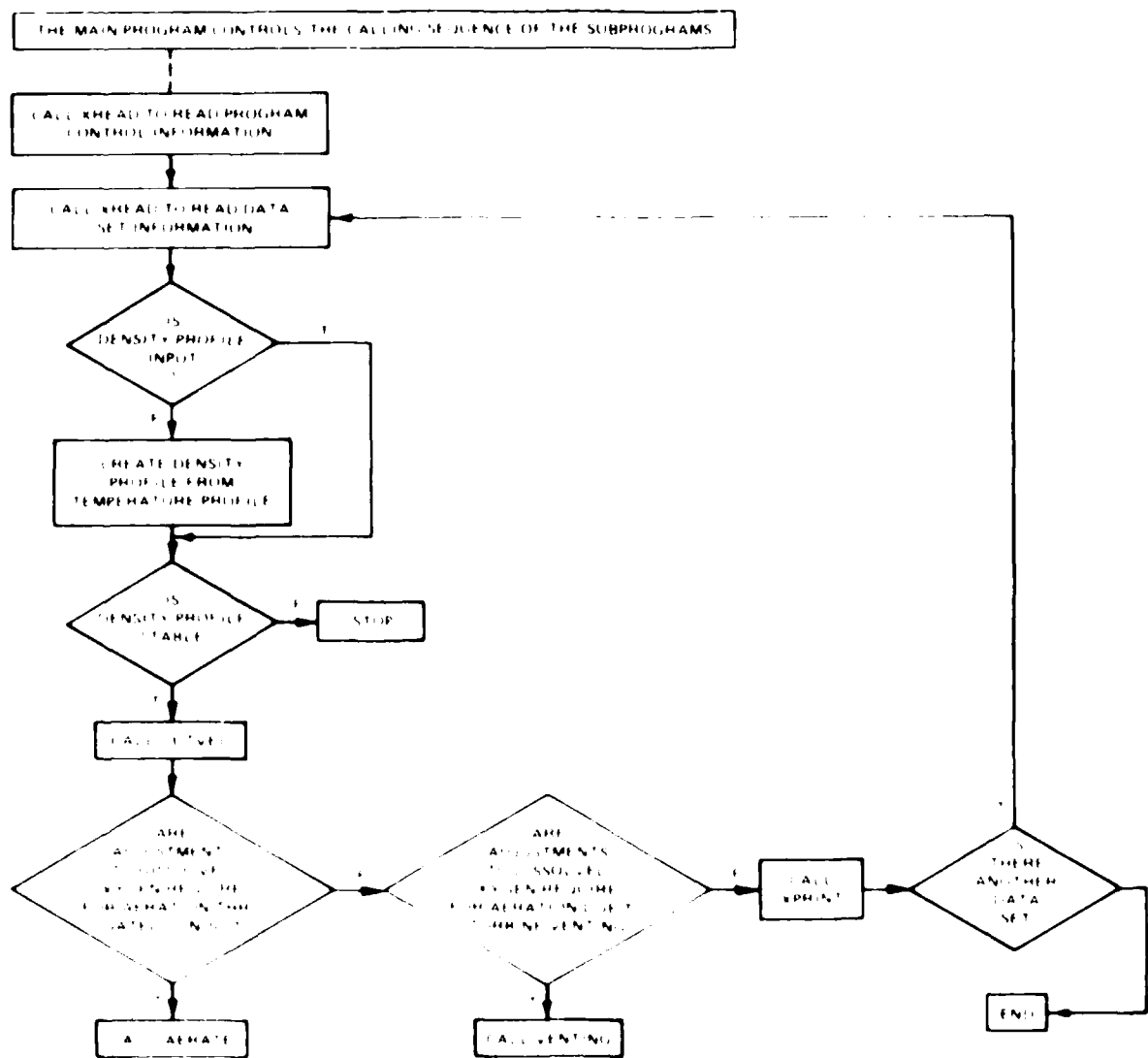


Figure 4. Main program flowchart

Table 1
Main Program Variables

| <u>Variable</u> | <u>Definition</u> |
|-----------------|--|
| C1 | Constant = -3.9863 ; used in determining density correspondence to a particular temperature |
| C2 | Constant = 508,929.2 ; used same as C1 |
| C3 | Constant = 288.9414 ; used same as C1 |
| C4 | Constant = 68.12963 ; used same as C1 |
| DEN(J) | Density of layer J, g/ml |
| ISURF | Total number of layers in a profile |
| KFILE | Output file code |
| NSETS | Number of data sets in the input file |
| QAERA | Logical variable; true, consider DO uptake due to aeration through a gated structure outlet works; false, do not consider aeration |
| QCENT | Logical variable; true, temperatures are in degrees Centigrade; false, Fahrenheit |
| QDEN | Logical variable; true, density profile is input; false, develop density profile from temperature |
| QVENT | Logical variable; true, consider DO uptake due to turbine venting; false, do not consider uptake |
| TEMP(J) | Temperature of layer J, degrees Fahrenheit or Centigrade |

DENINT

Description

25. Function DENINT determines the density at any elevation. The user-input density profile (or temperature profile which SELECT converts to a density profile) is interpolated by subroutine INTERP to give densities at each layer center line. When the density at some arbitrary elevation is desired, DENINT uses the layer center-line densities above and below the given elevation and linearly interpolates to determine the density at the given elevation. Figure 5 shows a schematic of the algorithm flowchart, and Table 2 lists the variables used in DENINT.

26. The interpolation equation is

$$\Gamma_A = \Gamma_{I+1} - \left(\frac{d}{D}\right) (\Gamma_{I+1} - \Gamma_I) \quad (2)$$

where

- Γ_A = density at the given elevation of point A
- Γ_{I+1} = density at the elevation of the layer I+1 center line immediately above point A
- d = distance between the elevation of point A and the elevation of the layer center line immediately above
- D = distance between the layer center lines immediately above and immediately below point A
- Γ_I = density at the elevation of the layer I center line immediately below point A

A schematic defining these variables is shown in Figure 6.

Special considerations

27. If point A lies within 0.01 percent of the layer thickness of a center line, the density at the elevation of point A is assigned the value of the density at the layer center line.

28. When a density value is desired for an elevation that is above the impoundment surface or below the impoundment bottom, linear extrapolation is used (the need for such a calculation is explained in the section on subroutine VPORT). For an elevation above the surface, SELECT uses the change in density and difference in elevation between

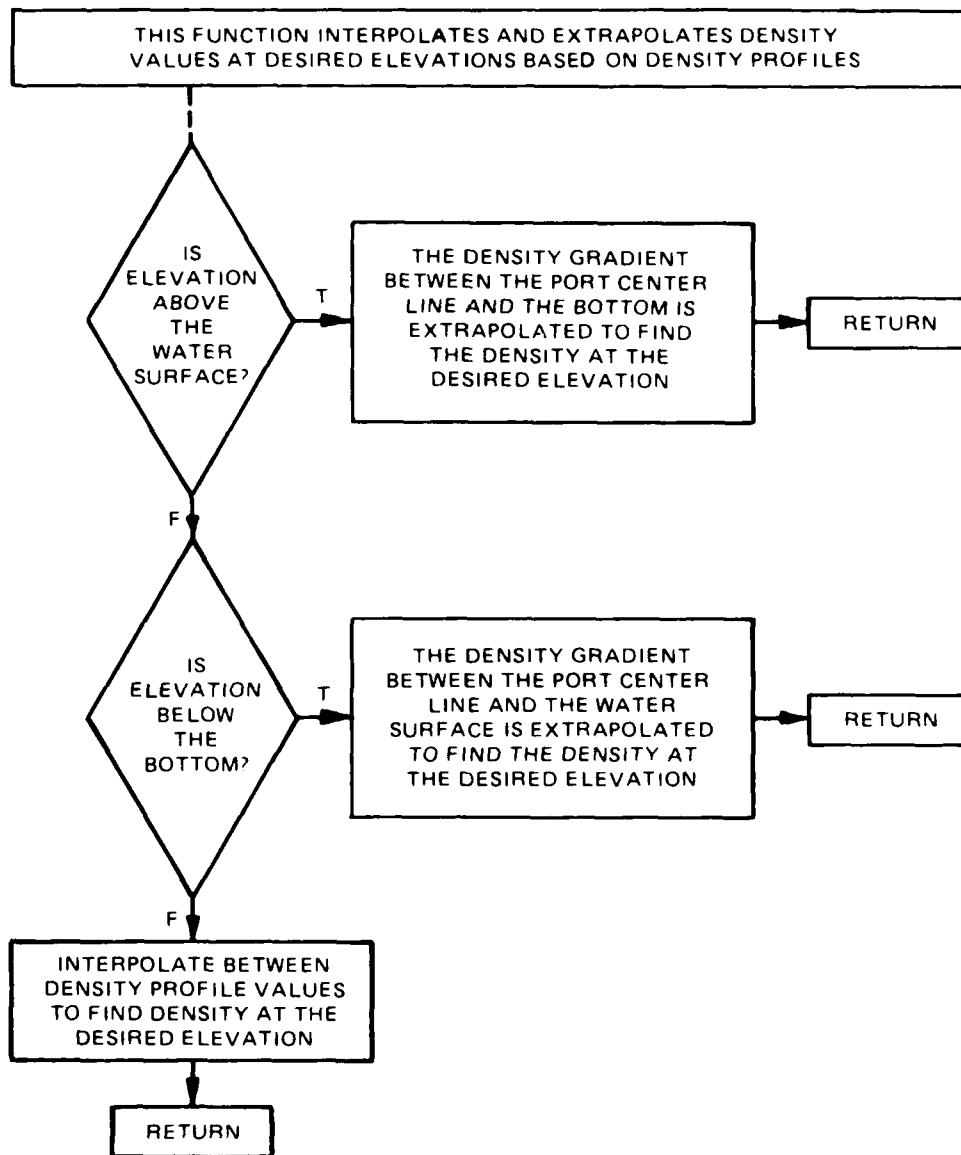


Figure 5. Flowchart for function DENINT

Table 2
DENINT Variables

| <u>Variable</u> | <u>Definition</u> |
|-----------------|--|
| DELZ | Layer thickness |
| DEN(J) | Density of layer J, g/cm ³ |
| DEN(IJ) | Density of upper interpolation layer, g/cm ³ |
| DEN(JK) | Density of lower interpolation layer, g/cm ³ |
| DENPRT | Density at the port center line |
| DEPTH | Depth of pool |
| DGRD | The density gradient used to determine artificial densities outside the pool boundaries |
| DGRDB | The density gradient from port to bottom; slope equals the density difference over the vertical distance between the port center line and the bottom |
| DGRDT | The density gradient from port to surface; slope equals the density difference over the vertical distance between the port center line and the surface |
| DIFF | Absolute difference between locations at which density is to be determined and nearest layer midpoint |
| ELMID | Location of midpoint of the layer containing the location at which density is to be determined |
| ELTOP | Elevation of midpoint of upper interpolation layer |
| HGTPRT | Height above bottom of port center line |
| IJ | Subscript of upper interpolation layer |
| IJK | 0 or 1; used to define interpolation layers |
| ISURF | Subscript of surface layer |
| JK | Subscript of lower interpolation layers |
| LAYER | Layer containing the location at which density is to be determined |

(Continued)

Table 2 (Concluded)

| Variable | Definition |
|----------|---|
| LAYER1 | Assigned the layer number value for layer calculated that lies outside the pool |
| NUMD | Total number of density values input for the density profile |
| OLDPRT | Assigned the value of HGTPRT |
| QEXTR | Logical variable; true when elevation of point is outside of pool; false when elevation of point is inside pool or at boundaries |
| SIGN | Equals 1, interpolation location is below midpoint of its layer; equals -1, interpolation location is above midpoint of its layer |
| SLOPE | Change in density between two interpolation layers divided by the vertical distance between the layers |
| SMALL | Essentially 0, used in check for constant density condition |
| X | Height above bottom at which density is desired |
| Y | Assigned the value of X for temporary storage |

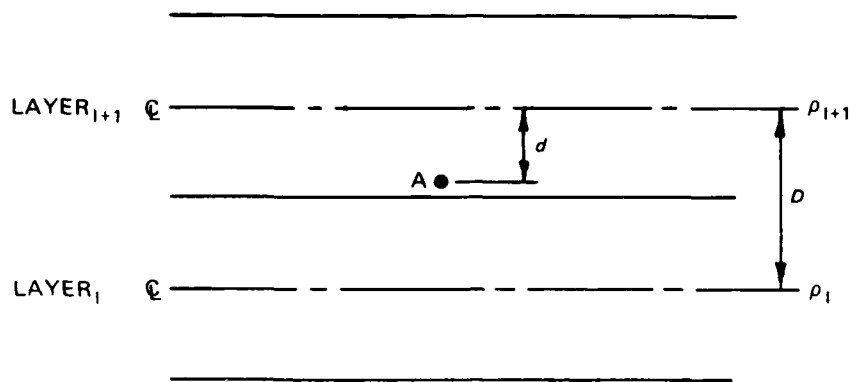


Figure 6. Schematic used to find density
at arbitrary elevation A

the port center line and surface to extrapolate the required density value (Figure 7). For an elevation below the bottom, SELECT uses the change in density and difference in elevation between the port center line and the impoundment bottom elevation (Figure 8) to extrapolate the needed density. In actuality, a density value outside the pool is artificial and is necessary only for computations in subroutines VPORT, VWEIR, and SHIFT.

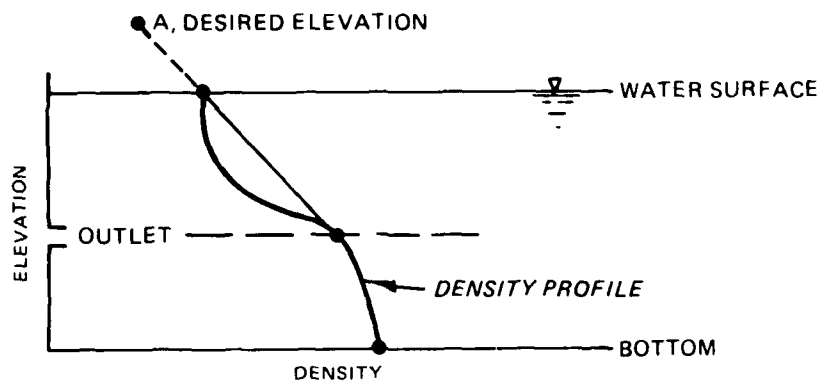


Figure 7. Diagram shows extrapolation of density gradient to determine density at an elevation above the surface

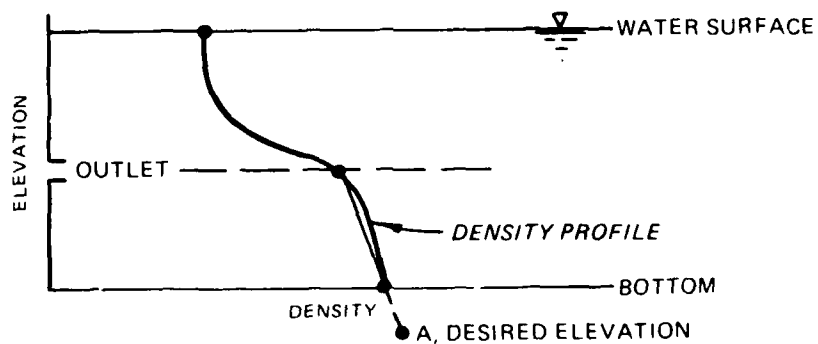


Figure 8. Diagram shows extrapolation of density gradient to determine density at an elevation below the bottom

INTERP

Description

29. Subroutine INTERP generates computational profiles based on user-input data profiles for all parameters to be modeled. INTERP uses linear interpolation of input profile values to determine a value for the center line of each computational layer. The necessity for profile values at the computational layer center lines is for numerical convenience and output organization only. For example, when the density at some arbitrary elevation is desired, the program determines which computational layer the elevation resides in and finds the layer center lines immediately above and below the elevation desired. It then interpolates between the two center-line density values to find the density at the desired elevation. Without the computational layer center-line values, the program would have to scan and compare every input data point elevation with the desired elevation until it found the data values immediately above and below the desired elevation, which is significantly less efficient. Since many of the algorithms in SELECT use profile information and are repeated many times, the use of computational layers is a timesaving necessity.

30. The use of computational layer center-line values may be less accurate than direct use of the actual data points since it results in interpolation between interpolated values; however, the errors incurred by this technique are not significant. Figure 9 is the computational flowchart of INTERP; Table 3 displays the variables used in INTERP.

Special considerations

31. Layer center-line elevations that lie in the pool above the highest input data point elevation are assigned the value of that highest data point. Layer center-line elevations that lie in the pool below the lowest input data point elevation are assigned the value of that lowest input data point.

32. If a layer center-line elevation lies within 0.01 percent of the layer thickness of a data point, the center line will be assigned the value of that data point.

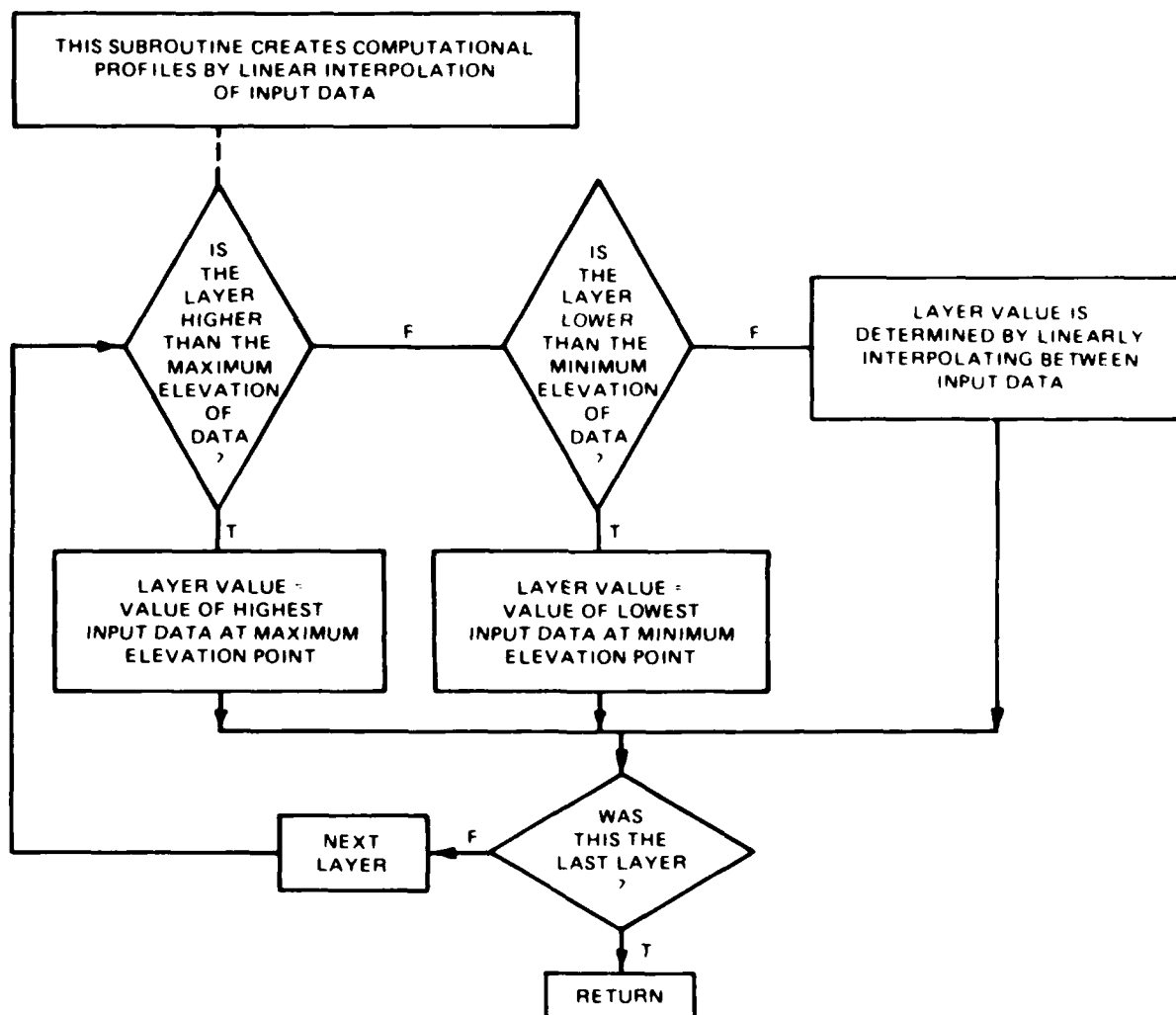


Figure 9. Flowchart of subroutine INTERP

Table 3
INTERP Variables

| <u>Variable</u> | <u>Definition</u> |
|-----------------|--|
| DIFF1 | Absolute difference in elevations of present layer midpoint and nearest profile point below it |
| DIFF2 | Absolute difference in elevations of present layer and the nearest profile point above it |
| DM(I) | Working storage used in resequencing heights into bottom-to-top order |
| ISURF | Total number of layers |
| J | Subscript of layer midpoint just above bottom of profile |
| K | Subscript of layer midpoint just below top of profile |
| L | Temporarily assigned layer values |
| NUMV | Number of input profile data points |
| NV | Number of input profile readings + 1; used in resequencing input profiles into bottom-to-top order |
| PM(I) | Working storage used in resequencing quality parameter values into bottom or top order |
| PQUAL(I) | Quality parameter value at midpoint of each layer after profile development in appropriate units |
| PVALUE(I) | Quality parameter values input as a profile in appropriate units |
| SIGN1 | Variable that keeps track of present lower profile point's position in relation to present layer midpoint |
| SIGN2 | Variable that keeps track of present higher profile point's position in relation to present layer midpoint |
| SMALL | Essentially zero; check for equality of two values |
| Y(I) | Height above bottom of the midpoint of each layer |
| YV(I) | Height above bottom of each input profile parameter |

33. If neither of the above cases is true, the program interpolates to find the layer center-line values using the equation

$$q_1 = \Delta q \cdot \frac{d}{D} + q_2 \quad (3)$$

where

q_1 = parameter value at the layer 1 center line

$\Delta q = q_2 - q_1$ = difference between parameter input

q_2 = parameter value of the input data immediately above the layer 1 center line

q_1 = parameter value of the input data point immediately below the layer 1 center line

d = elevation difference between the layer 1 center line and the lower input data point

D = elevation difference between the input data points immediately above and below the layer 1 center line

A schematic representation of this computation is given in Figure 10.

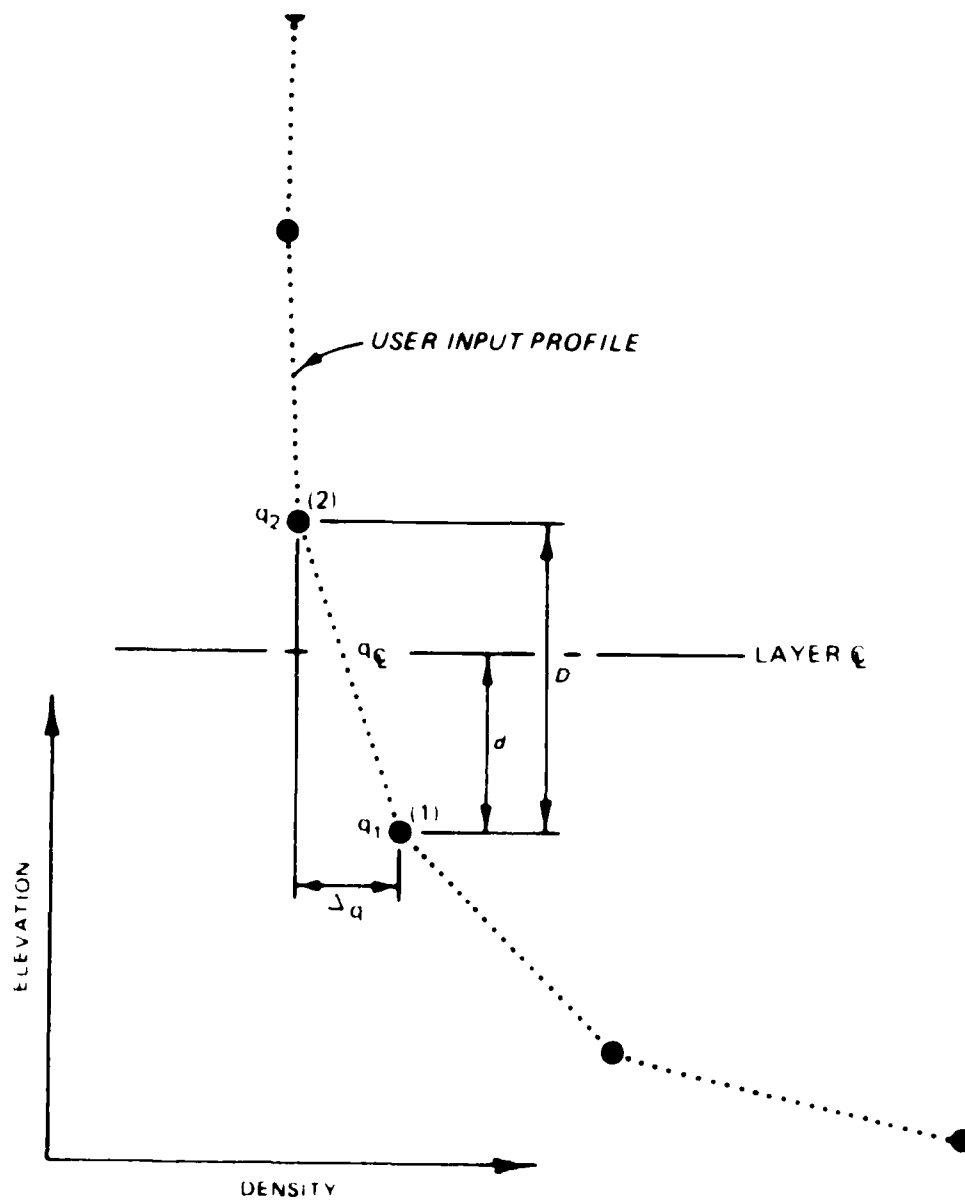


Figure 10. Schematic representation for Equation 3

OUTVEL

34. Subroutine OUTVEL controls the calling sequence of subroutines VWEIR, VPORT, and SHIFT. Based on the information returned from those subroutines, OUTVEL produces a total withdrawal profile and a total normalized velocity profile. OUTVEL also calculates the outflow density, temperature, and water quality concentrations as specified by the user. Figure 11 shows the algorithm flowchart. Table 4 lists descriptions of the subroutine variables.

Withdrawal profile computation

35. The withdrawal profile computed by VPORT or VWEIR is the profile for a port or weir, respectively. The profile values are given at the center-line elevations of the computational layers. When several outlets are modeled, each outlet generates an individual profile that contributes to the total withdrawal from each layer. The total withdrawal profile is found by summing the outflow values assigned to each layer resulting from flow through each outlet (Figure 12). Before this summation is carried out, however, subroutine SHIFT is executed to adjust the withdrawal limits of overlapping withdrawal zones, such as those shown in Figure 12. This accounts for reductions in shear resistance in the overlapping region, and the withdrawal profiles are adjusted accordingly.

Normalized velocity profile computation outflow parameters

36. The total normalized velocity distribution is developed from the total withdrawal distribution. The withdrawal from each layer is divided by the maximum layer withdrawal in the withdrawal zone. Thus, the layer of maximum discharge is assigned a normalized velocity of 1.0 and all others will have a velocity less than 1.0.

Outflow parameters

37. The outflow parameter values (density, temperature, and water qualities) are determined by a flow-weighted averaging technique using the equation

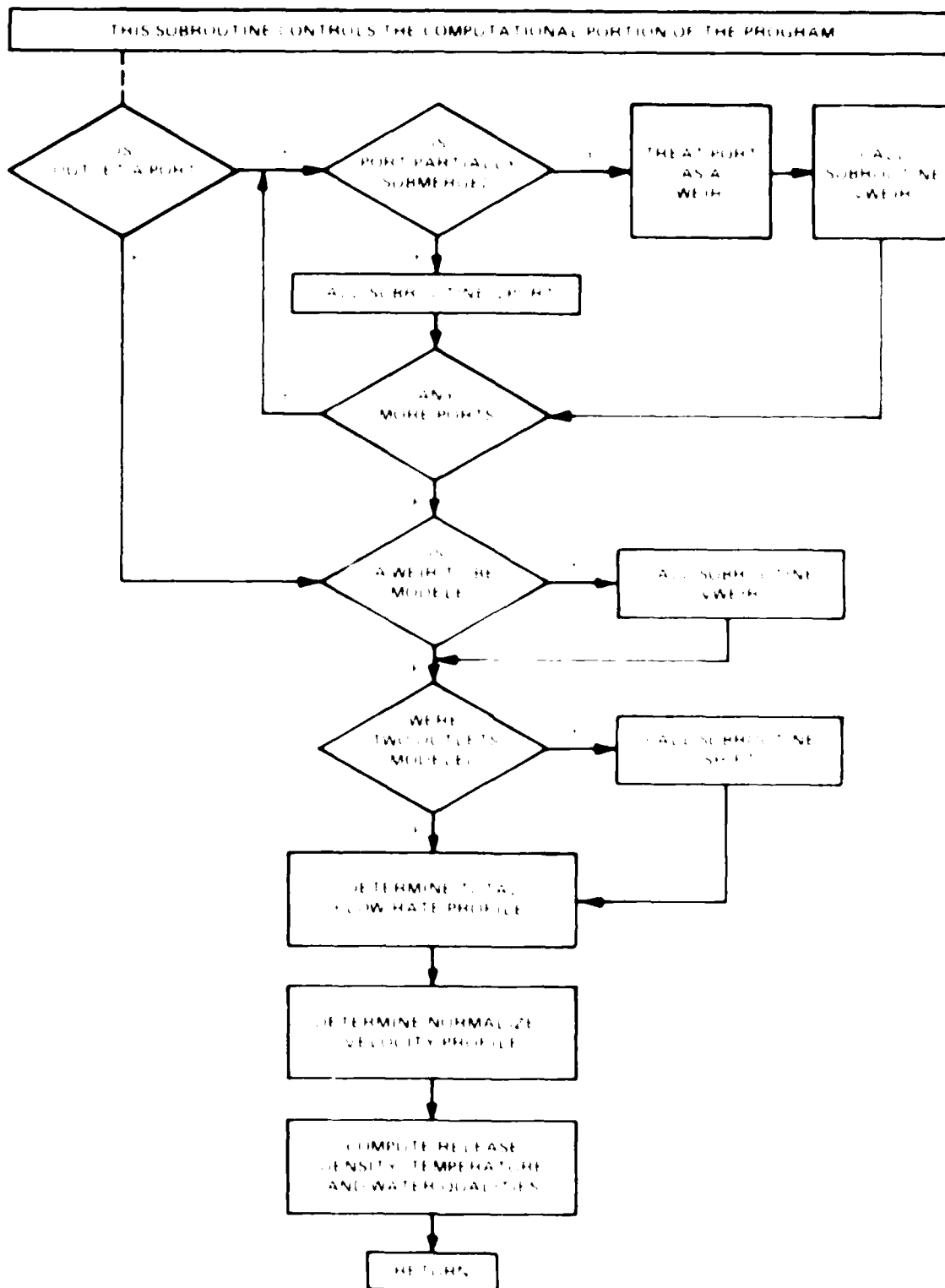


FIGURE 11. Flowchart for Subroutine 1 (WEIR)

Table 4
QUIVEL Variables

| <u>Variable</u> | <u>Definition</u> |
|-----------------|---|
| WEIR | Weir crest height above bottom |
| DENCL | Density of layer 1, g cm^3 |
| DENOUT | release density |
| DENPRT | Density at port center line |
| DEPTH | Depth of pool |
| FLDIF | Depth of water between the top of the port and water surface; used in empirical determination of partial port submergence |
| FLUBAL | Flow through one outlet |
| FLUWLi | release flow rate through i^{th} port |
| FLIM | Assigned value of FLBIM(K) locally |
| FLI11 | percentage of layer 1 that is filled with water |
| WLLW | height above bottom of lower withdrawal limit |
| WLLCL | Height above bottom of the port center line |
| WLLU | height above bottom of upper withdrawal limit |
| NUM | total number of layers |
| WLLW | height of weir crest |
| WLLW | height above lower withdrawal limit for outlet K is assumed |
| WLLW | height above lower withdrawal limit for one outlet is assumed |
| WLLW | height above upper withdrawal limit for outlet K is assumed |
| WLLW | height above upper withdrawal limit for one outlet is assumed |

TABLE 4

QUIVEL

Table 4 (Continued)

| Variable | Definition |
|-----------|---|
| NPORTS | Number of selective withdrawal ports |
| NQUAL | Number of quality parameters input |
| PHDIM(K) | Horizontal dimension of port K |
| PHGT(K) | Height above bottom of port K center line |
| PVDIM(K) | Vertical dimension of port K |
| QALOUT(N) | Average release concentration of N th water quality parameter, appropriate units |
| QPORT | Logical variable; true, ports are present as outlet devices; false, no ports |
| QPWEIR | Logical variable; true when a port is considered "partially submerged" and therefore modeled as a weir; false when the above is false |
| QSUB | Logical variable; true when weir is submerged; false when weir is <u>not</u> submerged |
| QTEMP | Logical variable; true for temperature profile input; false for no temperature profile |
| QUAL(J,I) | Value of the J th quality parameter for layer I |
| QWEIR | Logical variable; true when a weir is present as an outlet device; false when there is no weir |
| SUMDF | Sum over layers of the product of withdrawal flow and density |
| SUMOUT | Total flow rate through all outlets |
| SUMQF | Sum over layers of the product of withdrawal flow and quality |
| SUMTF | Sum over layers of the product of withdrawal flow and temperature |
| TEMOUT | Average temperature of outflow, degrees Fahrenheit or Centigrade |

(Continued)

(Sheet 2 of 3)

Table 4 (Concluded)

| Variable | Definition |
|-----------|--|
| TEMP(K) | Temperature value at layer K, degrees Fahrenheit or Centigrade |
| TOPLIM | Layer of pool where upper withdrawal limit for a given outlet is located |
| V(I) | Velocity profile value at layer I for flow through one given outlet |
| VDIM | Assigned value of PVDIM(K) locally |
| VEL(I) | Total velocity profile value of layer I for all outlets |
| VHL | Empirical value in the determination of partial submergence of a port |
| VMAX | Maximum normalized velocity equal to 1.0 |
| VS(I,K) | Velocity profile value of layer I for the K th outlet |
| VW | Empirical value used in the determination of partial submergence of a port |
| WANGLE | Assigned the value WTHETA(K) locally |
| WRHGT | Weir crest height above bottom |
| WRLNG | Weir length |
| WTHDRW(I) | Withdrawal flow rate from layer I |
| WTHETA(K) | Withdrawal angle for port K |
| ZDN(K) | Height above bottom of the lower withdrawal limit of outlet K |
| ZUP(K) | Height above bottom of the upper withdrawal limit of outlet K |

(Sheet 3 of 3)

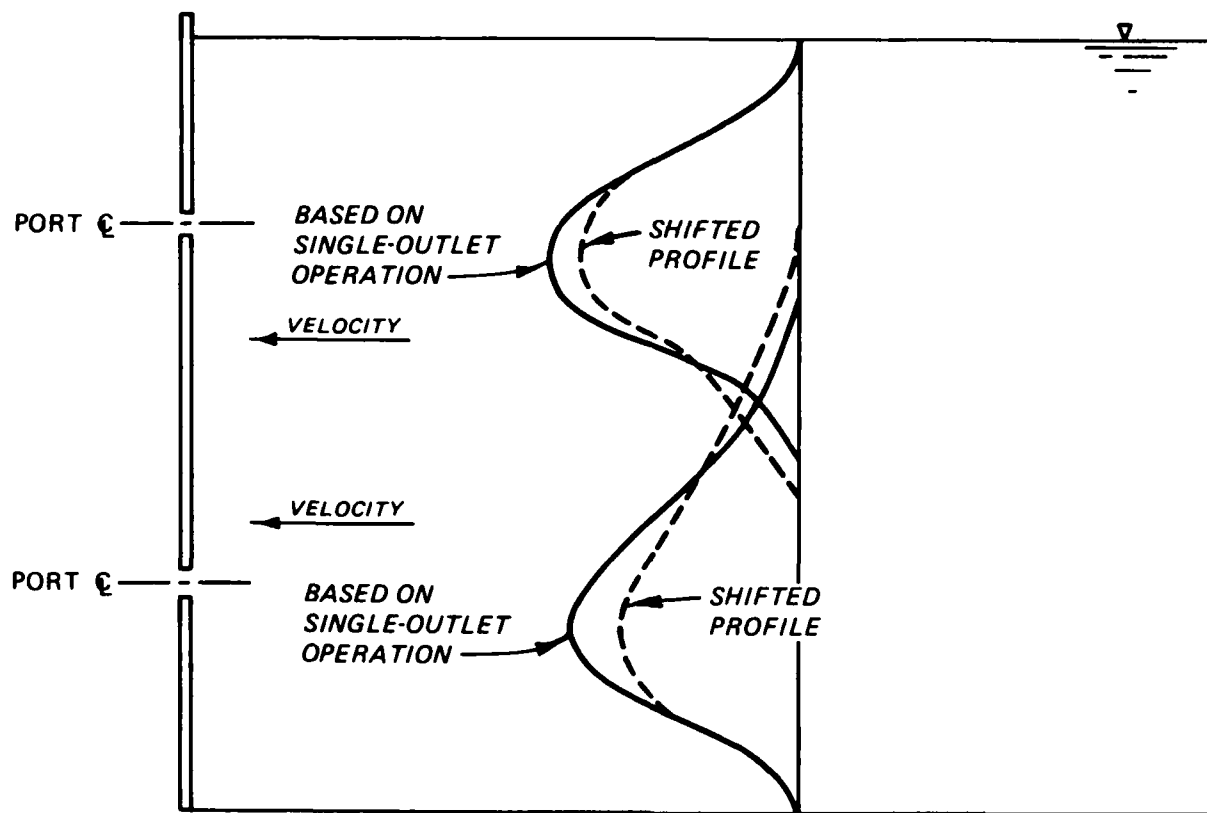


Figure 12. Schematic representation of overlapping withdrawal zones. The profiles are shifted (dashed lines) to better approximate actual profile

$$C_{TOT} = \frac{\sum (C_I * q_I)}{\sum q_I} \quad (4)$$

where

C_{TOT} = total outflow value or concentration

C_I = value or concentration of parameter for layer I

q_I = withdrawal from layer I

The concentrations or values of parameters in each layer are multiplied by the relative contribution of total flow from that layer and divided by the total flow rate from all outlets. Then, these flow-weighted parameter values for each layer are summed, yielding the total outflow parameter value. The outflow parameter calculations are performed for density, temperature, and quality constituents.

VPORT

38. Subroutine VPORT is the primary computational subprogram called by SELECT when port devices are modeled. VPORT determines the withdrawal zone limits and the associated flow rate profiles for a given port based on input data. The reader is reminded that subroutine OUTVEL performs tasks for the total release; VPORT performs its computations for only a single port per call. Figure 13 shows the computational flowchart for subroutine VPORT. Table 5 lists descriptions of the variables used by VPORT.

39. The following description of VPORT is presented in four parts: the determination of the withdrawal zone limits; the calculation of normalized velocities in the withdrawal zone; the generation of the profile; and the "point sink" calculation to verify that a point sink assumption is valid for the port being analyzed.

Withdrawal zone limits

40. The calculation of withdrawal zone limits is based on densimetric Froude number formulations developed by Bohan and Grace (1973) and Smith et al. (1987). The Bohan and Grace equation (modified for the withdrawal angle concept derived by Smith et al.) is used in three cases. One case is for no interference of the withdrawal zone with a boundary; the second is for simultaneous surface and bottom interference of the withdrawal zone; and the third is for determining the theoretical limit of a limit that experiences interference, while the other limit is free of interference.

41. The Smith et al. (1987) equation is used to find the limit that is free of interference when the other limit experiences interference. Boundary interference is defined to exist when the surface or bottom boundaries of the impoundment lie within the theoretical limits of the withdrawal zone, e.g., the limit cannot form freely within the pool because the impoundment surface or bottom interferes. The determination of limits is the same for no interference and for interference with both boundaries. The difference in the two conditions is not important for the calculation of the limits, but is important in

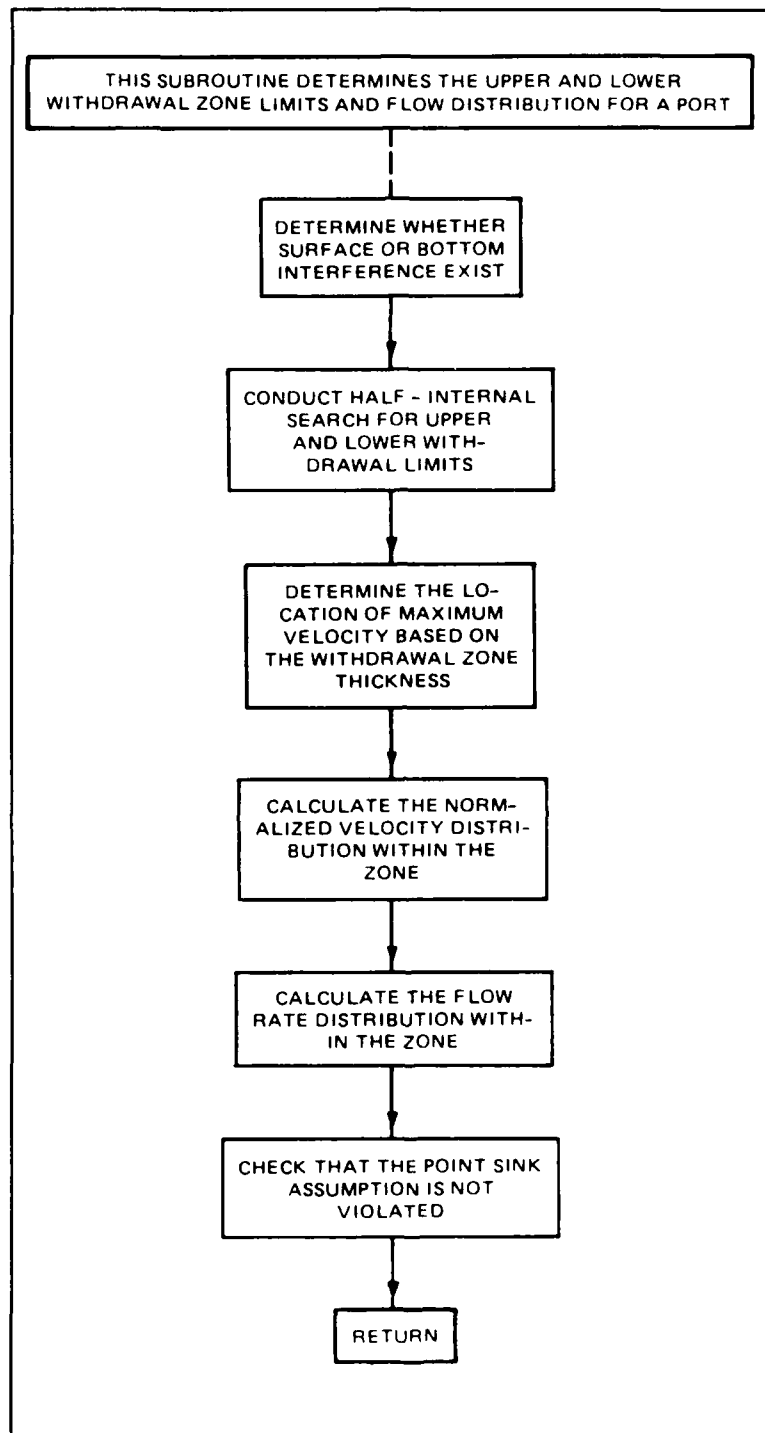


Figure 13. Flowchart for subroutine VPORT

Table 5
VPORT Variables

| <u>Variable</u> | <u>Definition</u> |
|-----------------|---|
| BONLIM | Assigned the value of zero for bottom interference or DEPTH for surface interference |
| C2 | Assigned the value of WANGLE/II |
| DELDEN | Density difference from layer of maximum velocity to local elevation, g/cm ³ |
| DELZ | Layer thickness |
| DEN(I) | Density of layer I, g/cm ³ |
| DENBOT | Density at the bottom of the impoundment |
| DENDIF | Density difference between fluid at layer ₃ of maximum velocity and a particular withdrawal limit, g/cm ³ |
| DENLIM | Assigned value of DENUPP for surface interference or DENBOT for bottom interference |
| DENLOW | Density at lower withdrawal limit, g/cm ³ |
| DENPRT | Density at port center line, g/cm ³ |
| DENTOP | Density at upper withdrawal limit, g/cm ³ |
| DENUPP | Density at surface of the impoundment |
| DEPTH | Depth of pool |
| DRBLIM | Density difference between fluid at the port center line and fluid at the port bottom |
| DRPBOT | Density difference between fluid at the port center line and the port invert |
| DRPTOP | Density difference between fluid at the port center line and the port top |
| DRTLIM | Density difference between fluid at the port center line and fluid at the port top |
| DVMAX | Density at location of maximum velocity, g/cm ³ |
| F1 | Value of withdrawal limit function QBNG(X) evaluated at X1 |

(Continued)

(Sheet 1 of 4)

Table 5 (Continued)

| Variable | Definition |
|----------|---|
| F2 | Same as F1 evaluated at X2 |
| F3 | Same as F1 evaluated at X3 |
| FLORAT | Flow rate through a port |
| G | Gravitational acceleration |
| H1 | Value of function QSMITH(X) evaluated at X1 |
| H2 | Same as H1 evaluated at X2 |
| H3 | Same as H1 evaluated at X3 |
| HGT(I) | Percentage of layer I that is filled with water |
| HGTLOW | Distance between pool bottom and lower withdrawal limit |
| HGTPRT | Distance between pool bottom and port center line |
| HGTTOP | Distance between pool bottom and upper withdrawal limit |
| ISURF | Total number of layers |
| LOWLIM | Layer of lower withdrawal limit |
| LVMAX | Layer of maximum velocity |
| MAX | Number of search iterations allowed to determine withdrawal limits |
| PHIFRAC | Fraction of flow within the truncated portion of the theoretical withdrawal zone |
| PI | Assigned the value of $\Pi = 3.14159$ |
| PRTBOT | Height of the invert of port |
| PRTTOP | Height of the upper edge of port |
| QBLIM | Logical variable; true for bottom withdrawal interference; false for no interference from bottom |
| QSHIFT | Logical variable; true when VPORT is called from SHIFT; false when call is not from SHIFT |

(Continued)

(Sheet 2 of 4)

Table 5 (Continued)

| Variable | Definition |
|----------|---|
| QSINK1 | Logical variable; true when point sink description is adequate for determination of lower withdrawal limit; false when the above is not true |
| QSINK2 | Same as QSINK1, except check is for the upper withdrawal limit |
| QTLIM | Logical variable; true for surface withdrawal interference; false for no interference from surface |
| RATIO | Ratio of the product of distance and density difference between the point of maximum velocity and a local point to the product of distance and density difference between the point of maximum velocity and a given limit |
| SINK1 | Empirical value used in determination of validity of point sink description for calculations of lower withdrawal limit |
| SINK2 | Same as SINK1, except now pertaining to upper withdrawal limit |
| SMALL | Essentially zero; check for approximate equality between two values |
| SUBR | Subroutine name |
| SUM | Sum over layers in the withdrawal zone of the velocity values for each layer |
| TINY | Essentially zero; used in value comparisons |
| TOPLIM | Layer of upper limit |
| TRUNCZ | For surface interference, it is the distance between the port center line and the surface; for bottom interference, it is the distance between the bottom and the port center line |
| V(I) | Normalized velocity profile value at layer I for a given port |
| VDIM | Assigned as value of PVDIM(K) locally |
| VDIM2 | One-half the vertical dimension of the port; $VDIM/2.0$ |
| VD2 | Equals VDIM2 or, if upper edge of port is above the pool surface, the distance between the surface and the port center line |
| VM | Scaling factor |

(Continued)

(Sheet 3 of 4)

Table 5 (Concluded)

| <u>Variable</u> | <u>Definition</u> |
|-----------------|--|
| VMAX | Maximum velocity in the normalized velocity profile; assigned as 1.0 |
| WANGLE | Withdrawal angle; equals WTHETA(K) from subroutine OUTVEL |
| X1 | Elevation of a search limit |
| X2 | A second limit search elevation |
| X3 | A third limit search elevation |
| X4 | A fourth limit search elevation |
| XDUMY | Assigned 0.0; used in ERROR () argument list |
| XDUMY1 | Same as XDUMY |
| XDUMY2 | Same as XDUMY |
| XDUMY3 | Same as XDUMY |
| XVMAX | Location of maximum velocity relative to the bottom |
| XXX | Used in label assignment statement |
| Y | Distance from elevation of maximum velocity to local elevation |
| YVMAX | Location of maximum velocity referenced to lower withdrawal limit |
| ZLOW | Distance between port center line and lower withdrawal limit |
| ZONE | Distance from lower withdrawal limit to upper withdrawal limit |
| ZONED | When surface or bottom interference exists (but not both), it equals the distance between the boundary of interference and the opposing withdrawal limit |
| ZTOP | Distance between port center line and upper limit |

(Sheet 4 of 4)

the calculation of the velocities within the withdrawal zone.

42. The Bohan and Grace equation, modified to include the withdrawal angle, is

$$\frac{Q}{Z^3 N} = \frac{\theta}{\Pi} \quad (5)$$

where

$$N = \frac{\Delta \rho}{\rho} \frac{g}{Z} \quad (6)$$

Q = flow rate

Z = distance between the port center line and the upper or lower withdrawal limit

θ = angle of withdrawal, in radians

Π = 3.14159 radians

$\Delta \rho$ = difference between the density at the upper or lower limit and the density at the port center line

ρ = density at the port center line

g = acceleration due to gravity

Figure 14 shows a schematic definition of these variables. Equation 5 is transcendental and cannot be solved directly since $\Delta \rho$ is a function of Z for the computation of N (Equation 6). Therefore, an iterative technique is needed to solve the equation for Z . Since Equation 5 and the Smith et al. (1987) equation, which follows, are transcendental and solved through iteration, a description of the iterative solution algorithm is withheld until after the Smith et al. equation is presented.

43. Smith et al. (1987) developed an equation that is an analytical extension of Equation 5 and is used to locate the limit that is free of interference when the other limit experiences boundary interference (Figure 15). The equation is

$$\frac{Q'}{D'^3 N} = \frac{0.125 \phi}{x^3} \frac{\theta}{\Pi} \quad (7)$$

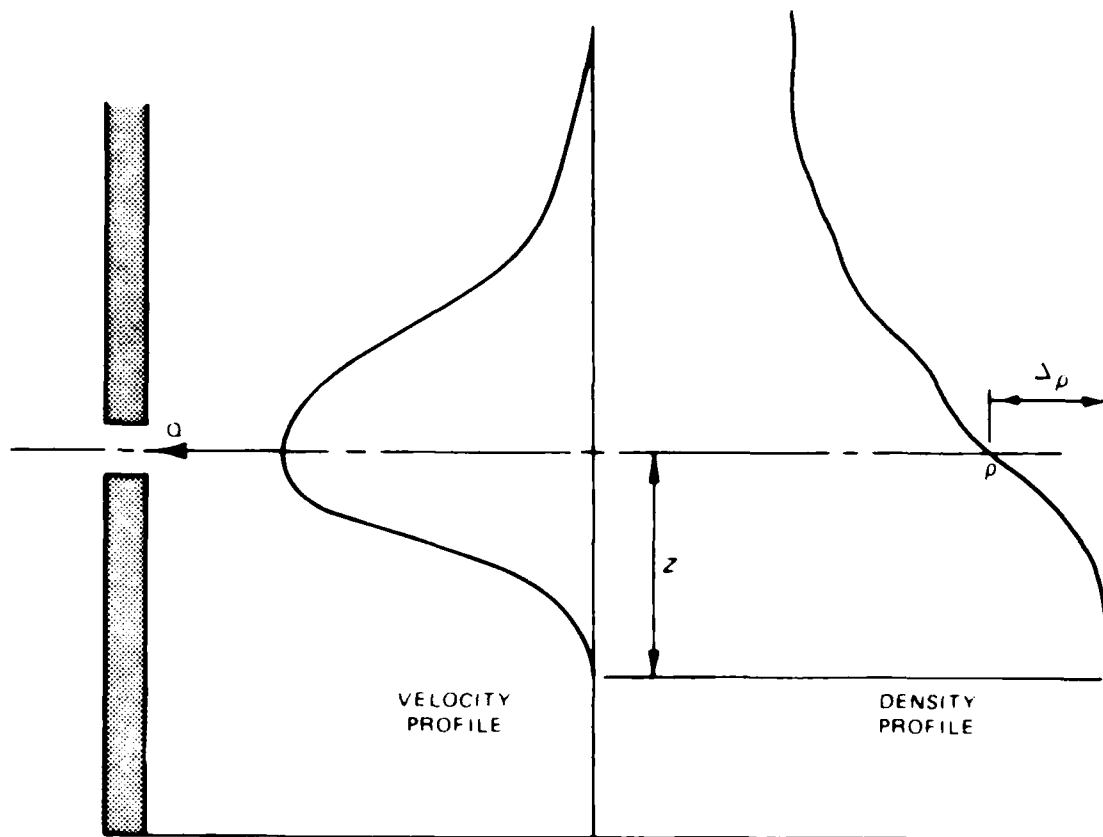


Figure 14. Variable definition schematic

where

$$\phi = \frac{1}{2} \left[1 + \frac{1}{\pi} \sin \left(\frac{b/D'}{1 - b/D'} \pi \right) + \frac{b/D'}{1 - b/D'} \right] \quad (8)$$

$$X = \frac{1}{2} \left[1 + \frac{b/D'}{1 - b/D'} \right] \quad (9)$$

where

Q' = discharge flow rate from the withdrawal zone

D' = distance between free withdrawal limit and boundary of interference

b = distance between port center line and boundary of interference

A schematic representation of this computation is given in Figure 15. Equation 7 is iteratively solved for D' . With D' known, the

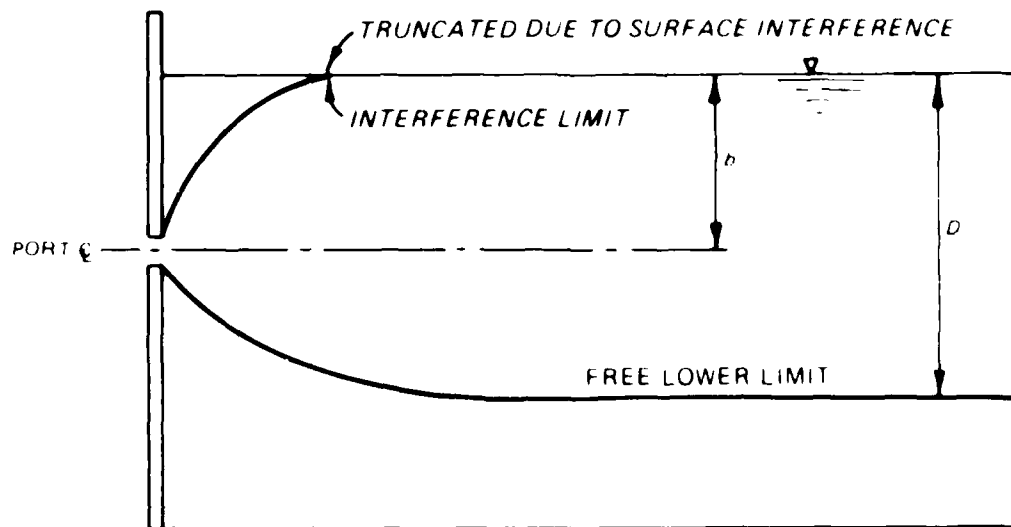


Figure 15. Schematic of a withdrawal zone with surface interference

location of the free limit (a distance D' from the limit of interference) is computed.

44. As mentioned earlier, Equations 5 and 7 are transcendental and therefore require an iterative solution. A half-interval search algorithm is used in SELECT and is discussed in the following paragraphs.
Half-interval search

45. Equations 5 and 7 are rearranged to give

$$Q - Z^3 N \frac{\theta}{\pi} = 0 \quad (10)$$

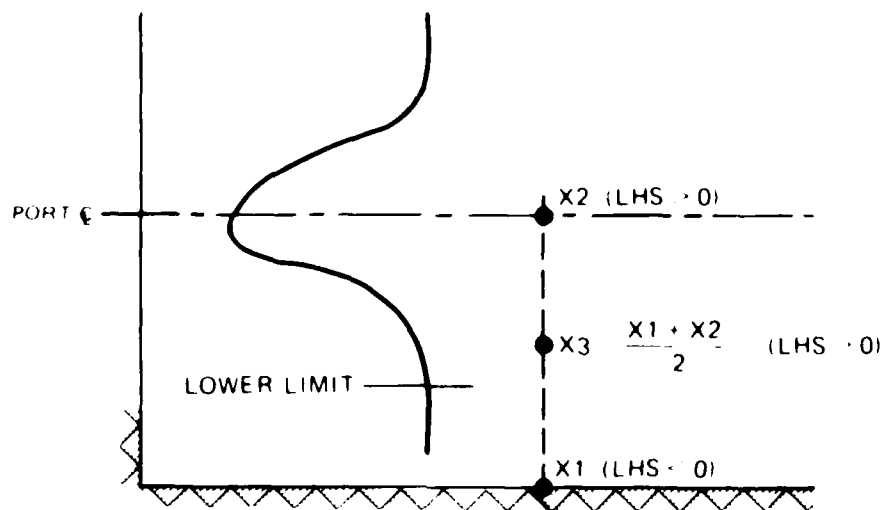
$$Q' - (D'^3 N) \left[\frac{1 + \sin \frac{b/D'}{1 - b/D'} \pi + \frac{b/D'}{1 - b/D'}}{\left(1 + \frac{b/D'}{1 - b/D'}\right)^3} \right] \frac{\theta}{2\pi} = 0 \quad (11)$$

These equations are then used to iteratively solve for Z (Equation 10) and D' (Equation 11). Note that if, during the iteration process, an appropriate Z or D' is chosen and substituted into Equation 10 or 11, respectively, the above equalities become true and the assumed Z or D' would be considered the solution to the equation. If a smaller or larger value is chosen, the left-hand side (LHS) of the equalities

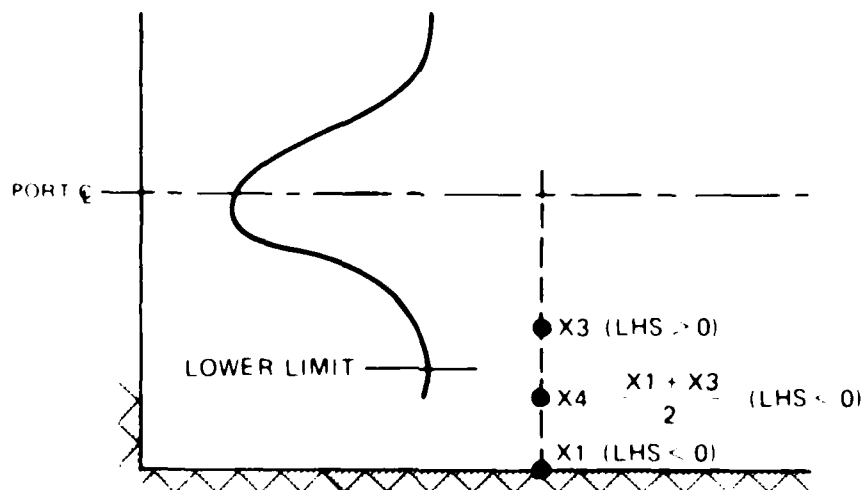
will be positive or negative, respectively. By systematically evaluating the magnitude and the sign of the LHS for various values of Z or D' , convergence to the solution can be achieved.

4b. For the sake of illustration, the following description of the search for a lower limit in a withdrawal zone free of interference is given. We are solving Equation 10. Note that the half-interval search determines one limit at a time.

- a. To begin the iteration process, two points are located: one point is assumed to lie above the limit (usually the outlet center-line elevation $X2 = 0.0$ since $X2$ is measured from the port center line downward); the other point is below the limit (a distance $X1$ below the port center line, usually at the bottom). Figure 16a illustrates this step.
- b. A third point ($X3$) is determined that is halfway between $X1$ and $X2$, hence, the half-interval search technique. Point $X3$ is assumed to be the withdrawal limit, and its Z value and corresponding density difference are substituted into Equation 10. If the LHS is zero or within a tolerable deviation from zero (10 percent of the layer thickness), $X3$ is taken as the actual limit. If the LHS of Equation 10 is negative, then $X3$ is below the actual limit. If the LHS is positive, $X3$ is above the actual limit.
- c. If $X3$ is not the solution after the first iteration is complete, then $X3$ replaces the limit ($X1$ or $X2$) that lies on the same side of the limit as it does. Thus, a new search region, which is the half of the original search region containing the solution, will be subjected to the same search technique. A new midpoint ($X4$) is found halfway between $X3$ and the remaining point ($X1$ or $X2$), at a quarter-point of the original search region. In this example, $X4$ is located on the opposite side of the limit from $X3$ (Figure 16b). It should be noted that $X4$ does not always reside on the opposite side of the limit from $X3$.
- d. The new point, $X4$, is assumed to be the withdrawal limit, and its Z value and corresponding density difference are substituted into Equation 10. The process described in c repeats itself until successive estimates for Z ($X3$ and $X4$) are found that lie within a tolerable distance from each other (10 percent of the layer thickness). The $X3$ or $X4$ value is then assigned as the actual limit.



a. Initial estimate of lower limit (X_3)



b. Second estimate of lower limit (X_4)

Figure 16. Illustration of search for lower withdrawal limit

- e. If the search does not converge within 10 iterations, an error message is output and program execution is terminated.

47. The following points should also be noted:

- a. When one limit experiences interference and the other does not, Equation 11 is used rather than Equation 10 in the search algorithm and the number of iterations allowed is increased from 10 to 20.
- b. Although boundary interference may physically constrain a limit to the given boundary, a theoretical value for that limit is determined assuming no interference. This allows the computation of the normalized velocity profile based upon the theoretical extent of the limits, thereby expressing the velocity at the boundary in terms of its theoretical potential. The zone is truncated at the boundary, and all velocity values outside the boundary are omitted (Figure 17) in subsequent computations.

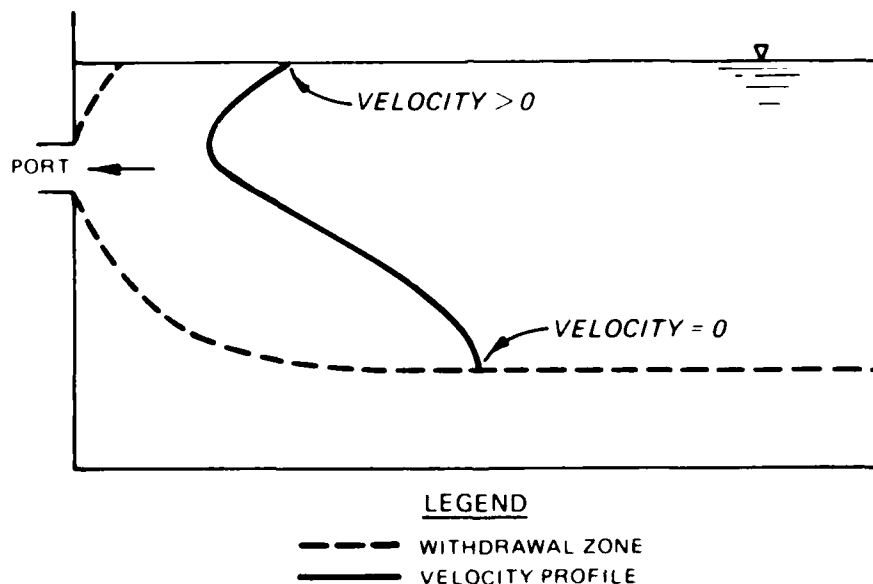


Figure 17. Velocities calculated above the water surface are truncated from velocity profile

Velocity profile computation

48. The velocity profile computations are based on the vertical location of the maximum velocity in the withdrawal zone. The location of maximum velocity is given by the equation (Bohan and Grace 1973)

$$Y_L = H * \sin \left(1.57 \frac{Z_L}{H} \right)^2 \quad (12)$$

where

Y_L = distance from lower limit to elevation of maximum velocity

H = vertical distance between the upper and lower withdrawal limits

Z_L = vertical distance between the outlet center line and the lower limit

Since the elevation of the lower limit is known, the elevation (and the layer) of maximum velocity can be determined. With the location of the layer of maximum velocity known, the velocity distribution can be determined.

49. Bohan and Grace (1973) found that Equations 13 and 14 described the vertical velocity distribution for withdrawal zones experiencing boundary interference and for zones free of interference, respectively.

$$\frac{V}{V_{MAX}} = 1 - \left(\frac{y}{Y} \frac{\Delta \rho}{\Delta \rho_{MAX}} \right)^2 \quad (13)$$

$$\frac{V}{V_{MAX}} = \left(1 - \frac{y}{Y} \frac{\Delta \rho}{\Delta \rho_{MAX}} \right)^2 \quad (14)$$

where

V = velocity value within a given layer of the withdrawal zone

V_{MAX} = maximum layer velocity value in the withdrawal zone

y = vertical distance from the elevation of maximum velocity to that of the given layer

Y = vertical distance between the elevation of maximum velocity and that of the upper or lower limit as appropriate

$\Delta \rho$ = difference in density between that at the elevation of maximum velocity and that at the given layer

$\Delta \rho_{MAX}$ = difference in density between that at the elevation of maximum velocity and that at the elevation of the upper or lower limit as appropriate

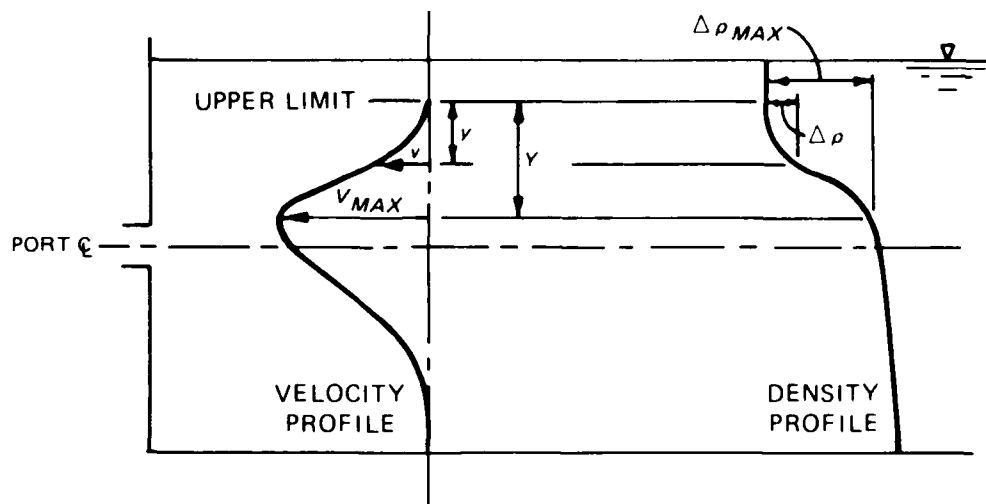


Figure 18. Schematic definition of variables for Equations 13 and 14

A definition sketch for these variables is given in Figure 18. Inspection of Equations 13 or 14 reveals that the product $(y/Y)(\Delta\rho/\Delta\rho_{MAX})$ has a maximum value of 1.0. Therefore, the maximum value of the right-hand side of this equation is 0.0. Since these velocity values will ultimately be scaled to provide a withdrawal profile (shown later), the assignment of V_{MAX} acts only to change the constant used for scaling these profiles. In order to develop the normalized velocity distribution (velocities with values between 0 and 1), V_{MAX} is assigned in VPORT to be 1.0. Thus, the V computed in Equations 13 and 14 is also a normalized velocity. The computation of velocity for each layer is then a straightforward calculation since the variables y , Y , $\Delta\rho_{MAX}$, and $\Delta\rho$ are known for each layer. The computation of the entire velocity profile is accomplished by individual operations for each portion of the withdrawal zone above and below the elevation of the point of maximum velocity.

Special considerations

50. The maximum velocity (1.0) will be assigned to all withdrawal layers above or below the elevation of maximum velocity if the layer densities do not vary from the density at the elevation of maximum velocity, i.e., $\Delta\rho = 0$.

Conversion of velocities to flow rates

51. Once the normalized velocity distribution is determined for a port, the withdrawal profile, i.e., a flow rate, is calculated for each layer based on the total flow rate through the port. The equation used to compute the withdrawal profile is

$$q_I = \frac{V_I}{\sum V_I} Q_T \quad (15)$$

where

q_I = withdrawal from the I^{th} layer

V_I = normalized velocity at the I^{th} layer

Q_T = total flow rate through a port

Point sink assumption

52. One of the basic assumptions in the theory underlying SELECT is that ports may be considered point sinks, i.e., port dimensions are insignificant compared to withdrawal zone thickness. To ensure that the outlet configuration is consistent with the point sink assumptions, the program performs empirically based calculations (see next paragraph) to assess whether the point sink assumption is violated. If the assumption has been violated, a warning statement is issued in the output alerting the user to the violation of the assumption. Should the user receive such a statement, more extensive modeling may be required.

53. Using the illustration in Figure 19 to aid in the description of the variables, the following inequalities are defined to ascertain the applicability of the point sink assumption:

$$\frac{(\Delta\rho_L * Z_L)}{(\Delta\rho_B * h)} > 3.0 \quad (16)$$

$$\frac{(\Delta\rho_U * Z_U)}{(\Delta\rho_T * h)} > 3.0 \quad (17)$$

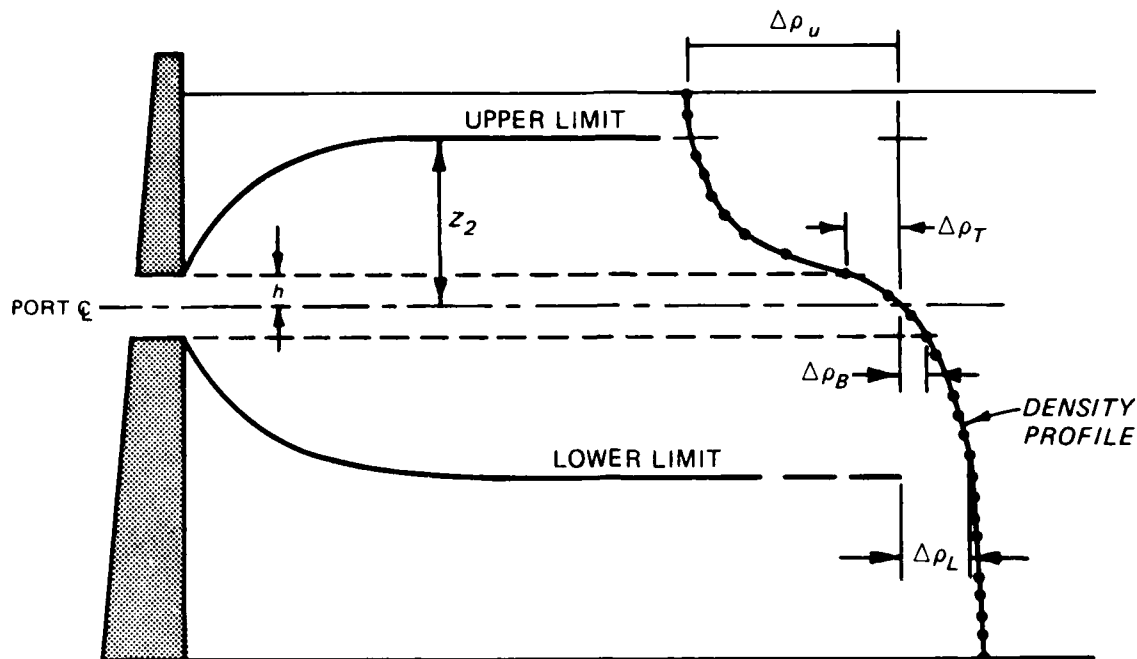


Figure 19. Definition sketch of variables for point sink assumptions

where

$\Delta\rho_L$ = density difference between the port center line and the predicted lower limit

Z_L = distance from the port center line to the lower limit

$\Delta\rho_B$ = density difference between the port center line and the invert of the port

h = one-half the vertical dimension of the port

$\Delta\rho_U$ = density difference between the port center line and the predicted upper limit

Z_U = distance from the port center line and the upper limit

$\Delta\rho_T$ = density difference between the port center line and the top of the port

When Equation 16 is true, a point sink description of withdrawal through the port is not applicable for determining the lower limit. When it is false, a point sink description is valid. When Equation 17 is true, a point sink description of withdrawal through the port is not valid for the upper limit. When it is false, a point sink description is valid.

VWEIR

54. Subroutine VWEIR is the computational subprogram called by OUTVEL when an outlet is modeled as a weir. VWEIR determines the withdrawal zone limits and associated profile for withdrawal over a weir under the assumption that the weir crest is above the thermocline. If this assumption is violated, SELECT may produce erroneous output. It should be noted that the impoundment surface is taken as the upper limit for any type of weir modeled. Also, if the bottom interferes with the lower limit, the bottom is taken as the lower limit.

55. The equation used in VWEIR to calculate the withdrawal zone limit is based on studies and analysis performed by Grace (1971) and additional analytical and empirical development at the WES. Subroutine VWEIR incorporates a formulation based on the densimetric Froude number F_D to describe weir withdrawal such that

$$F_D = \frac{\bar{V} H_w}{\sqrt{\frac{\Delta \rho}{\rho} g (Z + H_w)^3}} = C - D \frac{H_w}{(Z + H_w)} \quad (18)$$

where

\bar{V} = average velocity in the withdrawal zone

H_w = head above the weir crest elevation

$\Delta \rho$ = difference in density of fluid at the weir crest and the lower limit

ρ = density at the weir crest elevation

g = acceleration due to gravity

Z = distance between the crest elevation and the lower withdrawal limit

$$C = 0.54 \quad \text{and} \quad D = 0 \quad \text{for} \quad \frac{Z + H_w}{H_w} \geq 2.0$$

$$C = 0.78 \quad \text{and} \quad D = 0.70 \quad \text{for} \quad \frac{Z + H_w}{H_w} < 2.0$$

56. Rearranging Equation 18 yields

$$0 = \bar{V} - C \frac{(Z + H_w)}{H_w} \sqrt{\frac{\Delta \rho}{\rho} g(Z + H_w)} + D \sqrt{\frac{\Delta \rho}{\rho} g(Z + H_w)} \quad (19)$$

With Equation 19, it is possible to solve for the withdrawal limit Z by iteration. The half-interval search, outlined in VPORT, is used in a similar manner in VWEIR except that Equation 19 is used as the iterative equation. Figure 20 shows the computational flowchart of VWEIR.

Table 6 lists descriptions of the variables used in subroutine VWEIR.

Velocity profile

57. The calculation of a normalized velocity profile for a weir is based on the equations developed by Bohan and Grace (1973). Two conditions influence which equation governs the description of the profile: (a) whether the portion above or below the elevation of maximum velocity is being described, and (b) whether the weir is free or submerged. The following listing accounts for the conditions under which the equations are used.

58. Submerged weir. The location of the point of maximum velocity is computed exactly as it is for an orifice, as described in paragraph 51 of the subroutine VPORT description. The portion of the profile above the elevation of maximum velocity is described by

$$\frac{V_2}{V_{MAX}} = 1 - \left(\frac{y_2 \Delta \rho_2}{Y_2 \Delta \rho_{2m}} \right)^2 \quad (20)$$

where

V_2 = layer velocity in the zone of withdrawal at a distance y_2 above the elevation of maximum velocity

V_{MAX} = maximum layer velocity in the withdrawal zone, equals 1.0 for normalized distribution (see discussion of V_{MAX} in section on VPORT)

y_2 = vertical distance from the elevation of maximum velocity to that of the corresponding layer velocity V_2

$\Delta \rho_2$ = density difference of fluid between the elevations of the maximum velocity and the corresponding layer velocity V_2

Y_2 = vertical distance from the elevation of the maximum velocity to the upper limit of the zone of withdrawal

$\Delta \rho_{2m}$ = density difference of fluid between the elevation of the maximum velocity and the elevation of the upper limit

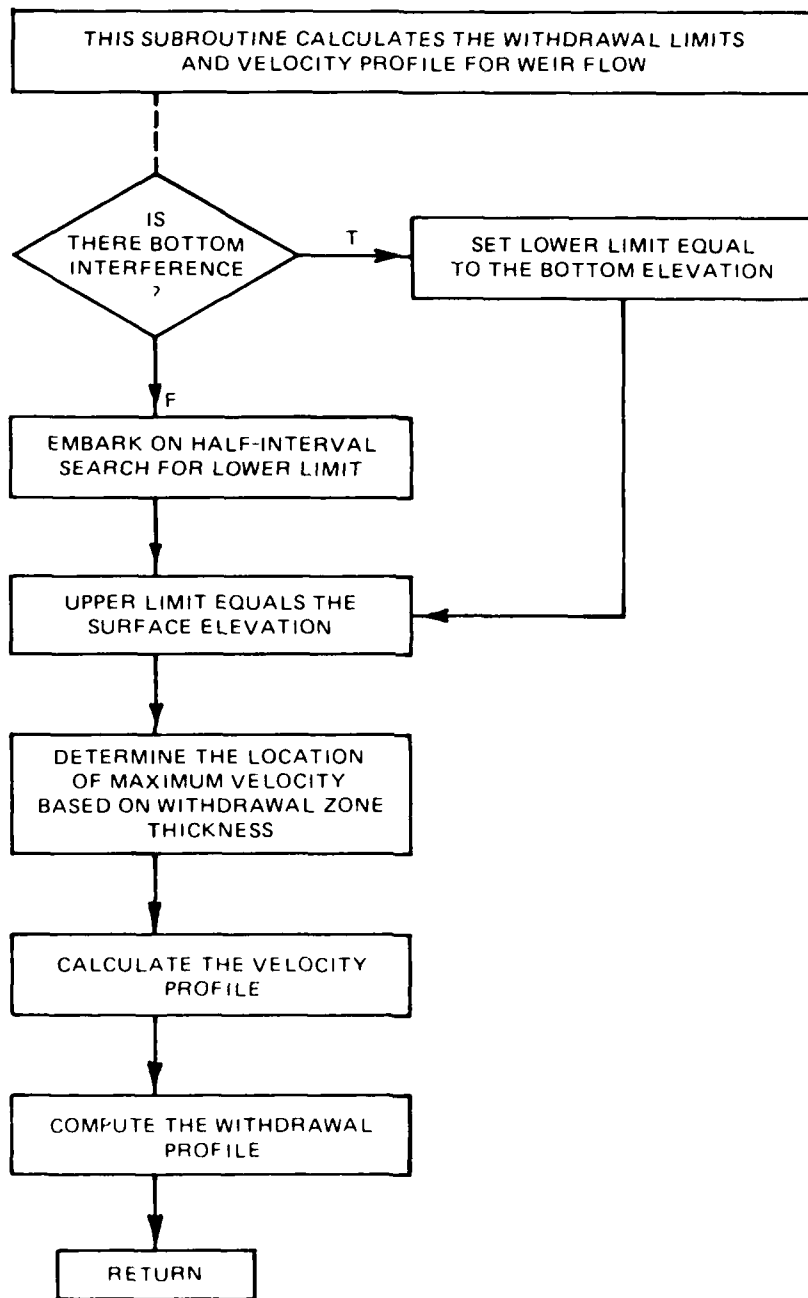


Figure 20. Flowchart for subroutine VWEIR

Table 6
VWEIR Variables

| <u>Variable</u> | <u>Definition</u> |
|-----------------|--|
| A | Coefficient used in determining the velocity profile exponent as a function of the discharge coefficient |
| AVGVEL | Average velocity over weir |
| B | Coefficient used in determining the velocity profile exponent as a function of discharge coefficient |
| C | Coefficient used in the FWEIR(X) function; has values of 0.54 or 0.78 |
| COEF | Weir discharge coefficient |
| CREST | Weir crest height above bottom |
| D | Second coefficient used as C; possible values are 0.0 to 0.70 |
| DELDEN | Density difference between fluid at layer of maximum velocity and fluid at a local elevation |
| DELZ | Layer thickness |
| DEN(I) | Density of layer I, g/cm^3 |
| DENDIF | Density difference between fluid at layer of maximum velocity and fluid at a withdrawal limit, g/cm^3 |
| DENLOW | Density at lower withdrawal limit, g/cm^3 |
| DENTOP | Density at upper withdrawal limit, g/cm^3 |
| DEPTH | Depth of pool |
| DVMAX | Density at location of maximum velocity, g/cm^3 |
| EXPNT | Exponent for velocity profile equation for free weir flow |
| F1 | Value of withdrawal limit function FWEIR(X) evaluated at X1 |
| F2 | Same as F1 evaluated at X2 |
| F3 | Same as F1 evaluated at X3 |

(Continued)

(Sheet 1 of 4)

Table 6 (Continued)

| Variable | Definition |
|----------|---|
| FLORAT | Flow rate over weir |
| G | Gravitational acceleration |
| HEAD | Head above weir crest |
| HGT(I) | Percentage of layer I that is filled with water |
| HGTLOW | Height above bottom of lower limit |
| HGTTOP | Height above bottom of upper limit |
| ISURF | Total number of layers |
| ITMAX | Number of search iterations allowed to determine withdrawal limits |
| LENGTH | Length of weir crest |
| LOWLIM | Layer of lower limit |
| LVMAX | Layer of maximum velocity |
| P | Exponent for velocity profile function |
| Q1 | Logical variable; true for positive withdrawal limit function; false for negative |
| Q2 | Logical variable; true for positive withdrawal limit function; false for negative |
| QZ | Logical variable; true when the vertical distance between the crest and the lower unit is less than the head above the crest, i.e., $Z_o/H_w < 1$; false, when the above is not true |
| QBLIM | Logical variable; true for bottom withdrawal interference; false for no interference from bottom |
| QSHIFT | Logical variable; true when VWEIR is called from SHIFT; false when not called from SHIFT |
| QSUB | Logical variable; true when the weir is submerged; false when not submerged |

(Continued)

(Sheet 2 of 4)

Table 6 (Continued)

| Variable | Definition |
|----------|---|
| QTLIM | Logical variable; true for surface withdrawal interference; false for no interference from surface |
| QZ | Logical variable; true when the vertical distance between the crest and the lower limit is less than the head above |
| RATIO | Ratio of the product of distance and density difference between the point of maximum velocity and a local point to the product of the distance and density difference between the point of maximum velocity and a given limit |
| SMALL | Essentially zero; check for approximate equality of two values |
| SUM | Sum over layers of the velocities for each layer |
| SUBR | Subroutine name |
| TOPLIM | Upper withdrawal limit |
| V(I) | Normalized velocity profile for weir |
| VM | Scaling term equal to FLORAT/SUM |
| VMAX | Maximum velocity in the normalized velocity profile, 1.0 |
| WRDEN | Density at weir crest, g/cm ³ |
| X1 | Elevation of an initial search limit |
| X2 | Elevation of a second search limit |
| X3 | Elevation of a third search limit |
| X4 | Elevation of a fourth search limit |
| XCHECK | Local variable for the value of $Z + H_w/H_w$ |
| XDUMY | Assigned 0.0; used in ERROR () argument list |
| XDUMY1 | Same as XDUMY |
| XDUMY2 | Same as XDUMY |

(Continued)

(Sheet 3 of 4)

Table 6 (Concluded)

| <u>Variable</u> | <u>Definition</u> |
|-----------------|--|
| XDUMY3 | Same as XDUMY |
| XVMAX | Distance from bottom to elevation of maximum velocity |
| Y | Distance from location of maximum velocity to local elevation |
| YLOW | Distance from location of maximum velocity to lower withdrawal limit |
| YTOP | Distance from location of maximum velocity to upper withdrawal limit |
| YVMAX | Location of maximum velocity referenced to lower withdrawal limit |
| ZLOW | Difference between crest elevation and lower withdrawal limit |
| ZONE | Distance from lower withdrawal limit to upper withdrawal limit |

(Sheet 4 of 4)

59. A description of the portion of the profile below the elevation of maximum velocity for a submerged weir is given by

a. Without bottom interference

$$\frac{V_1}{V_{MAX}} = \left(1 - \frac{y_1 \Delta \rho_1}{Y_1 \Delta \rho_{1m}} \right)^3 \quad (21)$$

b. With bottom interference

$$\frac{V_1}{V_{MAX}} = 1 - \left(\frac{y_1 \Delta \rho_1}{Y_1 \Delta \rho_{1m}} \right)^2 \quad (22)$$

where

V_1 = layer velocity in the zone of withdrawal at a distance y_1 below the elevation of maximum velocity

V_{MAX} = maximum layer velocity in the withdrawal zone; taken as 1.0 for normalized distribution (see V_{MAX} discussion in section on VPORT)

y_1 = vertical distance from the elevation of maximum velocity to that of the corresponding layer velocity V_1

$\Delta \rho_1$ = density difference of fluid between the elevations of the maximum velocity and the corresponding layer velocity V_1

Y_1 = vertical distance from the elevation of the maximum velocity to the lower limit of the zone of withdrawal

$\Delta \rho_{1m}$ = density difference of fluid between the elevations of the maximum velocity and the elevation of the lower limit

60. Free weir. A description of the portion of the profile below the elevation of maximum velocity is given by

$$\frac{V_1}{V_{MAX}} = 1 - \left(\frac{y_1 \Delta \rho_1}{Y_1 \Delta \rho_{1m}} \right)^P \quad (23)$$

where the exponent P varies with the user's choice of a weir coefficient COEF such that for

$|\text{COEF} - 3.00| < 0.1$, $P = 1.5$

$|\text{COEF} - 3.33| < 0.1$, $P = 0.5$

$|\text{COEF} - 4.10| < 0.1$, $P = 0.2$

where $||$ denotes the absolute value of the expression. If none of the above is true, $P = 4.35 - (1.04)COEF$.

61. The velocity for each layer is found directly since all variables y_i , Y_i , $\Delta\rho_{im}$, and $\Delta\rho_i$ ($i = 1$ or 2) are known for each layer in the withdrawal zone.

Special considerations

62. The maximum normalized velocity (1.0) is assigned for each withdrawal layer above and below the elevation of maximum velocity if the layer's density does not vary from the density at the elevation of maximum velocity, i.e., $\Delta\rho_i = 0$.

Conversion of velocities to flow rates

63. Once the normalized velocity profile is determined for the weir, the withdrawal profile is calculated based on the total flow rate over the weir. The flow value for each layer is scaled to sum to the magnitude of the total outflow over the weir. Equation 15 (in the VPORT section) is used to calculate the layer withdrawals based on the normalized velocities.

SHIFT

Description

64. Subroutine SHIFT adjusts the limits of withdrawal zones that overlap vertically when multilevel outlets are operated. The adjustment is necessary to correct the difference between the simple superposition of the predicted withdrawal zones for each outlet and the actual zone as observed during testing (see Figure 21). It is believed

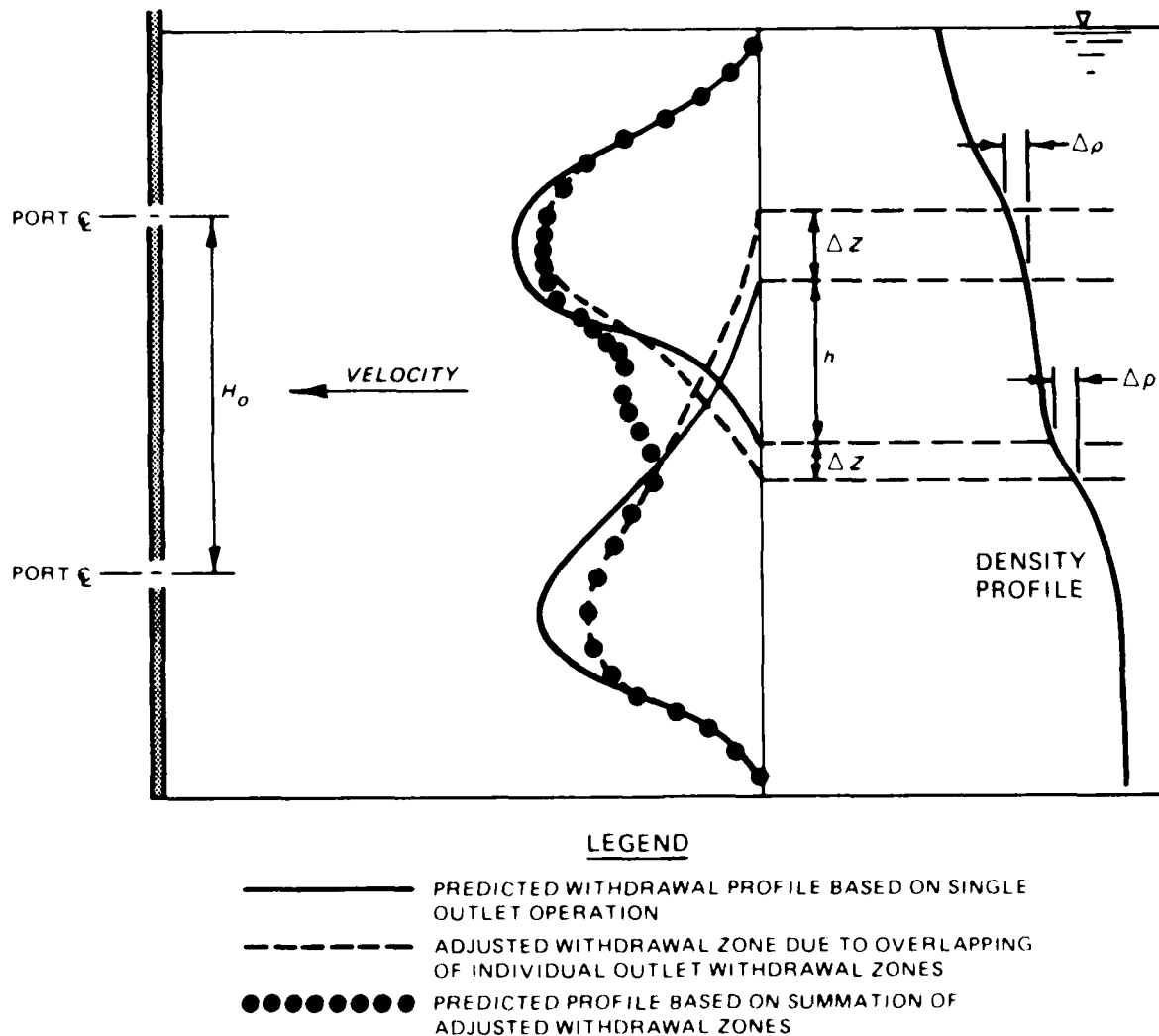


Figure 21. Schematic diagram of differences between initially calculated theoretical withdrawal zones and shifted withdrawal zones

that the difference exists because the fluid motion in one withdrawal zone tends to help the fluid movement in the other zone overcome the shear resistance forces in the region of overlap. Since the predicted velocity profile for each individual outlet does not take into account this apparent reduction in shear resistance, the superposition of the individually predicted profiles will not account for it either.

65. Bohan and Gloriod (1972) found that the discrepancy between the simple superposition of withdrawal zones and the actual zone was relatively consistent in laboratory testing. They concluded that the limits of the overlapping zones could be systematically adjusted to increase the zone thickness, thereby modifying the velocity distribution to produce individual withdrawal zones whose superposition closely approximated the actual zone. Bohan and Gloriod determined that the adjustment was a function of the amount of overlap of the two individual zones, the vertical spacing between the outlets, the density distribution of the impoundment, and the average velocity of each withdrawal zone in the region of overlap. The equation developed and used in SHIFT is

$$\frac{V_h}{\sqrt{\frac{\Delta\rho}{\rho} g \Delta z}} = 0.70 \left(\frac{h}{H_o} \right)^{1.25} \quad (24)$$

where

V_h = average velocity in the region of overlap of the upper or lower withdrawal zones as appropriate

$\Delta\rho$ = density difference between the old limit and the shifted limit

ρ = density at the original limit

g = acceleration due to gravity

Δz = vertical shift of the withdrawal limit

h = vertical distance of overlap

H_o = vertical distance between ports

66. Rearranging, Equation 24 becomes

$$V_h - 0.7 \left(\frac{h}{H_o} \right)^{1.25} \sqrt{\frac{\Delta\rho}{\rho} g \Delta z} = 0 \quad (25)$$

The vertical shift Δz can be found by iteration. The iterative algorithm used is similar to the half-interval search described in the VPORT section. A flowchart of the SHIFT subroutine is shown in Figure 22. Table 7 describes the variables used in this algorithm.

Special considerations

67. If the surface interferes with the new shifted limit and the density at the surface is within 1×10^{-7} of density at the port, the shifted limit is assigned to the surface elevation. Also, if the bottom interferes with the new shifted limit and the density at the bottom is within 1×10^{-7} of the density at the port, the bottom is assigned as the limit. Thus, the upper limit of the lower port's withdrawal zone may experience surface interference and the lower limit of the upper port's withdrawal zone may experience bottom interference.

68. After the new limits are found for each withdrawal zone, SHIFT calls VPORT or VWEIR to recompute the flow rate profile for each zone based on the new limits and then transfers program control back to subroutine OUTVEL.

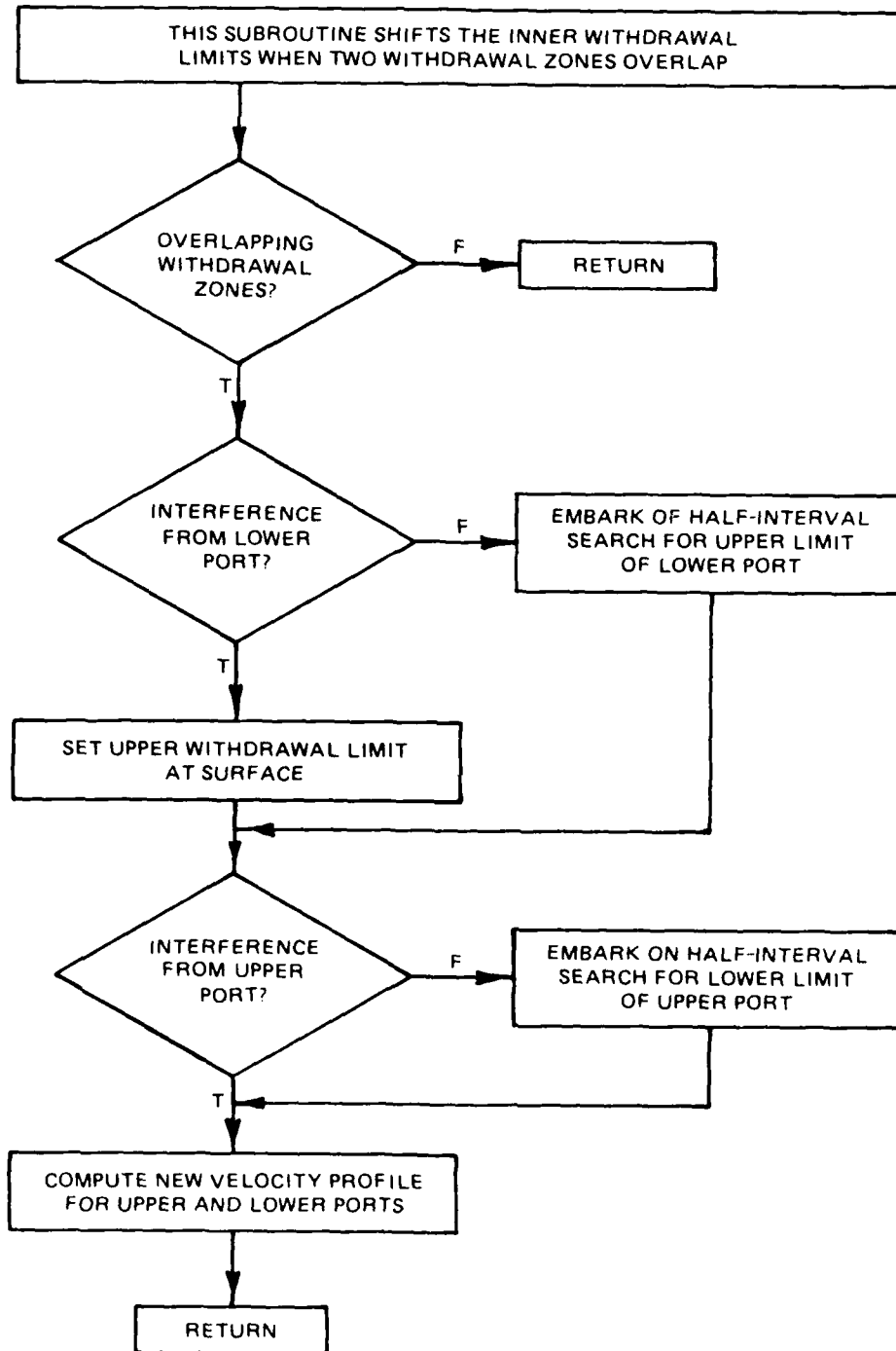


Figure 22. Flowchart for subroutine SHIFT

Table 7
SHIFT Variables

| <u>Variable</u> | <u>Definition</u> |
|-----------------|--|
| CREST | Weir crest height above bottom |
| DELZ | Layer thickness |
| DEN(I) | Density of layer I, g/cm ³ |
| DENS1 | Density at elevation of lower withdrawal limit for the outlet K + 1, g/cm ³ |
| DENS2 | Density at elevation of upper withdrawal limit for the outlet K, g/cm ³ (note: the elevation of port K is below that of port K + 1) |
| DEPTH | Depth of pool |
| F1 | Value of withdrawal limit shift function FSHIFT (VH, X, D, ZL) evaluated at X1 |
| F2 | Same as F1 evaluated at X2 |
| F3 | Same as F1 evaluated at X3 |
| FLORAT | Flow rate through one port or over a weir |
| FLOW(K) | Flow rate through port K |
| G | Gravitational acceleration |
| H | Distance between upper withdrawal limit of outlet K and lower withdrawal limit of outlet K + 1 |
| HGT(I) | Percentage of layer I that is filled with water |
| HGTLOW | Height above bottom of lower withdrawal limit |
| HGTPRT | Height above bottom of center line of port |
| HGTTOP | Height above bottom of upper withdrawal limit |
| HO | Distance between vertical location of outlets K and K + 1 |
| HTEST | Computed value used in withdrawal limit shift function |

(Continued)

(Sheet 1 of 4)

Table 7 (Continued)

| Variable | Definition |
|----------|---|
| ISURF | Total number of layers |
| KFILE | File code; KFILE = 06 is output file |
| L1 | Layer containing lower withdrawal limit of outlet K + 1 |
| L2 | Layer containing upper withdrawal limit of outlet K |
| LAY | Number of layers between L1 and L2 |
| LENGTH | Length of weir crest |
| LLOW(K) | Layer of pool at which lower withdrawal limit for outlet K is located |
| LOWLIM | Layer of lower limit |
| LTOP(K) | Layer of pool at which upper withdrawal limit for outlet K is located |
| MAX | Number of search iterations allowed to determine withdrawal limits |
| NOUTS | Number of selective withdrawal outlets |
| PHGT(K) | Height above bottom of port K center line |
| Q1 | Logical variable; true for positive value for withdrawal limit function FSHIFT (VH, X1, D, ZL); false, negative |
| Q2 | Same as Q1 for FSHIFT evaluated at X2 |
| QBLIM | Logical variable; true for bottom withdrawal interference; false for no interference from bottom |
| QPRINT | Logical variable; initially true, assigned false after print statement is executed; no other reassignment |
| QSB LIM | Logical variable; true when bottom withdrawal interference occurs after shifting limits; false when no such interference from bottom occurs |
| QSHIFT | Logical variable; true when VPORT or VWEIR is called; false when return back to SHIFT |

(Continued)

(Sheet 2 of 4)

Table 7 (Continued)

| Variable | Definition |
|----------|--|
| QSTLIM | Logical variable; true when top withdrawal interference occurs after shifting limits; false when no such top interference occurs |
| QTLIM | Logical variable; true for surface withdrawal interference; false for no surface interference |
| QWEIR | Logical variable; true when a weir exists as an outlet device; false when there is no weir |
| SMALL | Essentially zero; used in value comparisons |
| SUBR | Subroutine name |
| TINY | Essentially zero; used in value comparisons |
| TOPLIM | Layer of upper limit |
| V(I) | Velocity profile value of layer I for an outlet |
| VH1 | Average outflow of the outlet K in the zone of overlap of the K and K + 1 outlets |
| VH2 | Average outflow of outlet K + 1 in the zone of overlap of the K and K + 1 outlets |
| VS(I,K) | Velocity profile value of layer I for the K outlet |
| WRFLOW | Discharge over weir |
| WRHGT | Weir crest height above bottom |
| WRLNG | Weir length |
| X1 | Elevation of an initial search limit |
| X2 | Elevation of a second search limit |
| X3 | Elevation of a third search limit |
| X4 | Elevation of a fourth search limit |
| XDUMY | Assigned 0.0; used in ERROR () argument list |

(Continued)

(Sheet 3 of 4)

Table 7 (Concluded)

| Variable | Definition |
|----------|---|
| XDUMY1 | Same as XDUMY |
| XDUMY2 | Same as XDUMY |
| XDUMY3 | Same as XDUMY |
| XXX | Used in label assignment statement |
| ZDN(K) | Height above bottom of the lower withdrawal limit for outlet K |
| ZL1 | Height above the bottom of the lower withdrawal limit for the K + 1 outlet |
| ZL2 | Height above bottom of the upper withdrawal limit for the K outlet |
| ZUP(K) | Height above bottom of the upper withdrawal limit for outlet K |

(Sheet 4 of 4)

XPRINT

69. Subroutine XPRINT controls the output of all tabular information regarding elevations, depths, densities, normalized velocities, flow rates, temperatures, and water quality parameters. Each computational layer has characteristic values for all of the above categories, and subroutine XPRINT prints these parameter values for the layers at user-specified intervals such as at every layer or every third layer. XPRINT also summarizes input information, port center-line elevations, dimensions, crest elevation, crest length, and flow rate. A flowchart showing the organization of XPRINT is displayed in Figure 23. Table 8 lists descriptions of the variables used in XPRINT.

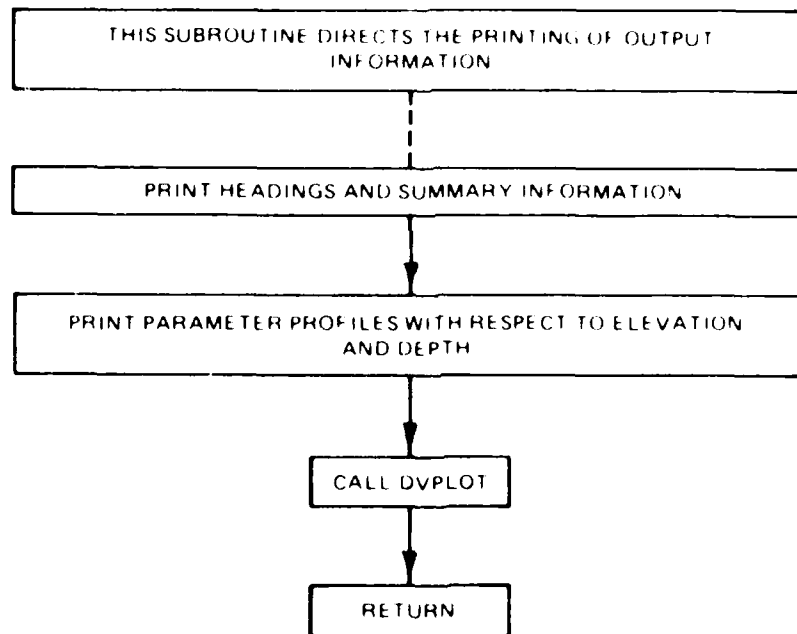


Figure 23. Flowchart for subroutine XPRINT

Table 8
XPRINT Variables

| Variable | Definition |
|------------|--|
| AWLBOT | Assigned result of intrinsic function AMAX1(X,Y); X = 0.0 , Y = ZDN(1) = lowest withdrawal limit |
| AWLUPP | Assigned result of intrinsic function AMIN1(X,Y); X = depth of pool, Y = ZUP (NOUTS) = uppermost withdrawal limit |
| AZDNEL | The elevation of AWLBOT, i.e., the elevation of the bottom or the lowest limit, whichever is highest |
| AZUPEL | The elevation of AWLUPP, i.e., the elevation of the surface or the uppermost withdrawal limit, whichever is lowest |
| BOTTOM | Elevation of bottom of pool |
| DEEP | Depth from surface to midpoint of layer |
| DELZ | Layer thickness |
| DEN(K) | Density of layer K |
| DENOUT | Average density of outflow, g/cm ³ |
| DEPTH | Depth of pool |
| DIST | Units of length used |
| ELEV | Elevation of midpoint of a layer |
| FLOW(L) | Flow rate through port L |
| G | Gravitational acceleration |
| HEADING(K) | Data set title; up to 80 characters in length |
| INTER | Interval between layers to be printed in output |
| ISURF | Total number of layers |
| KFILE | File code for output; KFILE = 06 |
| NAMEQ(K,J) | Name of the J th water quality parameter |
| NOUTS | Total number of selective withdrawal outlets |
| NPORTS | Number of selective withdrawal ports |
| NQUAL | Number of quality parameters input |
| PELEV | Elevation of a port center line |
| PHGT(L) | Height above bottom of port L center line |

Table 8 (Continued)

| Variable | Definition |
|-----------|---|
| PVDIM(K) | The vertical dimension of port K |
| QALOUT(I) | Average release concentration of the I th water quality parameter |
| QCENT | Logical variable; true for temperatures in degrees Centigrade; false for temperatures in degrees Fahrenheit |
| QMETR | Logical variable; true when units are metric (SI); false when units are English (non-SI) |
| QPLOT | Logical variable; true if line printer plot of density and total velocity profiles is desired; false if not desired |
| QPORT | Logical variable; true if ports are present as outlets; false if no ports |
| QPWEIR | Logical variable; true if a port is considered "partially submerged" and therefore modeled as a weir; false otherwise |
| QSINK1 | Logical variable; true when point sink description of port is adequate for calculation of lower withdrawal limit; false when otherwise (see point sink discussion in section on subroutine VPORT) |
| QSINK2 | Same as QSINK1, except now pertaining to upper withdrawal limit |
| QTEMP | Logical variable; true for temperature profile input; false for no input temperature profile |
| QUAL(J,K) | K th quality parameter value for layer J |
| QWEIR | Logical variable; true when a weir is included as an outlet device; false when there is no weir |
| SUMOUT | Total outflow through all outlets |
| SURFACE | Elevation of pool surface |
| TEMOUT | Average temperature of outflow, degrees Fahrenheit or Centigrade |
| TEMP(K) | Temperature of layer K, degrees Fahrenheit or Centigrade |
| TITLE(I) | Title of input file; up to 80 characters in length |
| VEL(K) | Total release velocity profile value of layer K |
| WELE | Elevation of weir crest |

(Continued)

(Sheet 2 of 3)

Table 8 (Concluded)

| Variable | Definition |
|-----------|---|
| WRFLOW | Flow rate over weir |
| WRHGT | Weir crest height above bottom |
| WRLNG | Weir length |
| WTHDRW(K) | Withdrawal flow rate for layer K |
| WTHETA(K) | Withdrawal angle for port K |
| XFEET | Equal to feet |
| XMETERS | Equal to meters |
| Y(K) | Height of midpoint of layer K above the bottom |
| ZDN(I) | Height above bottom of the lower withdrawal limit of outlet I |
| ZDNEL | Elevation of the lower withdrawal limit for the bottom outlet |
| ZUP(I) | Height above bottom of the upper limit of outlet I |
| ZUPEL | Elevation of upper withdrawal limit for the top outlet |

DV PLOT

70. Subroutine DV PLOT generates a line printer plot of elevation (and depth) versus density and velocity. This subroutine is called from subroutine XPRINT. Figure 24 and Table 9 show the algorithm flowchart for DV PLOT and a list of variable descriptions, respectively.

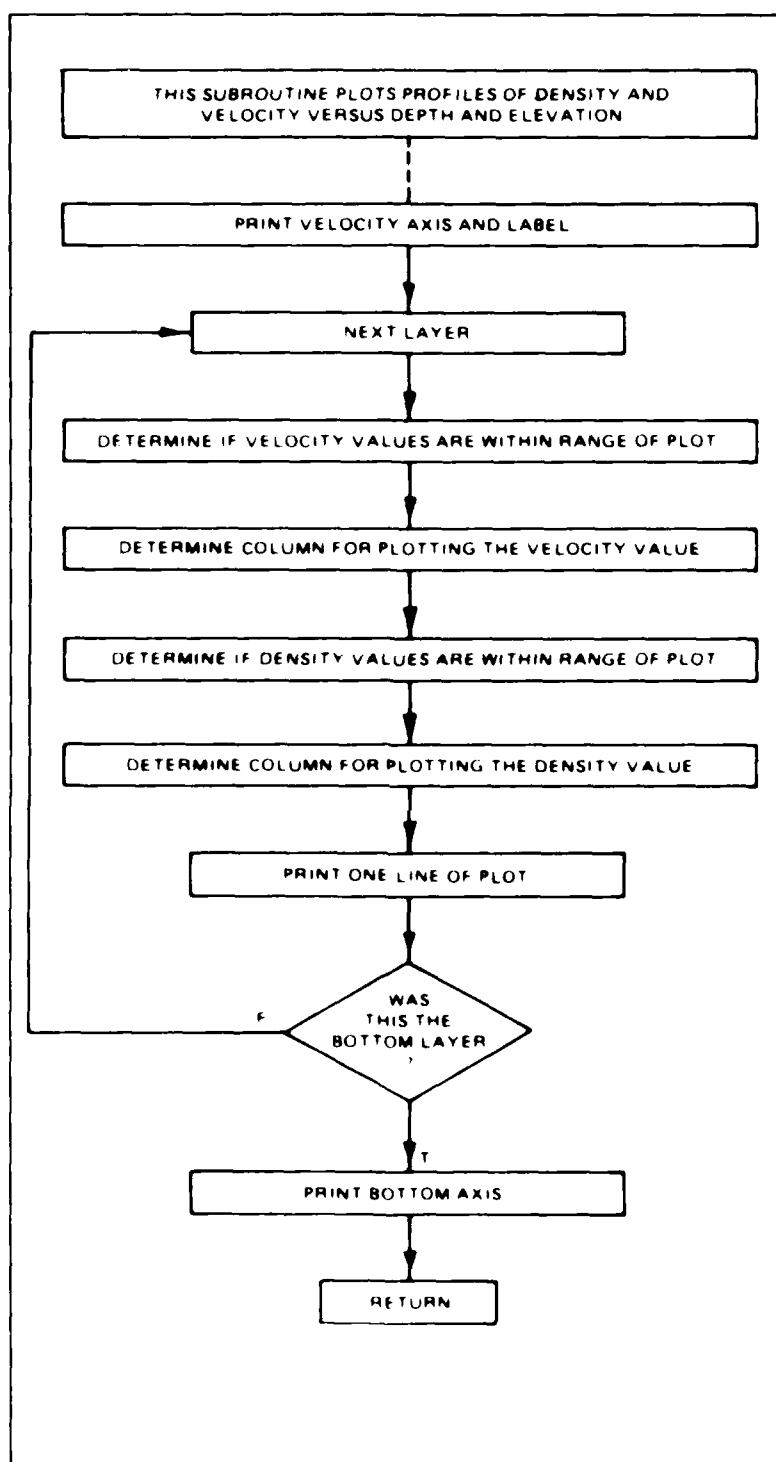


Figure 24. Flowchart for subroutine DVPLOT

Table 9
DV PLOT Variables

| Variable | Definition |
|------------|---|
| BLANK | Assigned value of 1H for FORMAT statements |
| BOTTOM | Elevation of pool bottom |
| CHANGE | Assigned value of 200; used to increment values along velocity axis of plot |
| CHANGE2 | Assigned value of DENDIF; used to increment values along density axis of plot |
| COLUMN(K) | Assigned value of variable BLANK or V; $K = 100$. There are 100 COLUMN values for each line printed. V is assigned to columns where a velocity greater than zero exists; used for plot marks |
| COLUMN2(K) | Same as COLUMN(K), except it is used for densities and symbol is D instead of V |
| D | Assigned value of 1HP in data statement; used as plot mark for density |
| DIF | Difference between the maximum and minimum densities in the profile when the minimum value is truncated after the third decimal place |
| DEEP | Used in loop, it begins at zero and is incrementally increased by a layer thickness. Each increment is printed on the vertical axis, thereby listing depth from surface to bottom |
| DEL | User-defined layer thickness |
| DEN(I) | The density of layer I |
| DENDIF | Difference between maximum and minimum densities on density axis |
| DMAX | The maximum density on the density axis of plot, assumed to be 1.00300 g/cm^3 |
| DMIN | The minimum density on the density axis of plot, assumed to be 0.99300 g/cm^3 |
| DN | Temporary assignment of DEN(I) |
| DSPACE | Value is incremented by CHANGE, and new value is printed on density axis of plot producing the density scale |
| DUM | Used to truncate DMIN after the third decimal point |

(Continued)

Table 9 (Continued)

| Variable | Definition |
|----------|--|
| ELEV | Used to print elevations of layers; first value is the elevation of the surface and following values are incrementally reduced by DELZ |
| FIRST | Assigned the value of variable BLANK or PEGGED; PEGGED is assigned when the density or velocity is less than or equal to zero. The value of FIRST is printed in the first column of the line being plotted |
| IJK | The column number in which the variable V or D is placed for variable array COLUMN and COLUMN2, respectively |
| ISURF | Number of layers |
| KFILE | Output file code |
| LAST | Assigned the value of variable BLANK or PEGGED; PEGGED is assigned when the velocity or density exceeds VELMAX or DMAX, respectively. LAST is printed in last column of plot |
| PEGGED | Assigned value of 1H* |
| PLUS | Assigned value of 2H+ |
| QRANGE | Logical variable; true when velocity value for layer lies between the minimum and maximum velocity value on the plot scale or when the layer density lies between the minimum and maximum density value on the plot scale; false when the above are not true |
| V | Assigned the value 1HV; used as plot mark for velocity |
| VEL(I) | Total release velocity profile value of the I th layer for all outlets combined |
| VELMAX | Assigned value of 2.0 |
| VL | Assigned the value of VEL(I) |
| VMAX | Maximum velocity in the velocity profile |
| VSPACE | Value is incremented by value of CHANGE, and new value is marked on velocity axis producing the velocity scale |

ERROR

71. Subroutine ERROR prints error messages and terminates program execution when one of the internal program checks (see Appendix D) has been failed. ERROR receives through its argument list an error number, the name of the subroutine in which the error occurred, the value of the variable CHECK (when applicable), and the values that were expected for CHECK (when applicable). The subroutine then prints the error number, the name of the subroutine-of-the-occurrence, and a brief statement as to the nature of the error, and terminates execution of the program. A flowchart of the subroutine is given in Figure 25, and a listing of variables used in subroutine ERROR is given in Table 10.

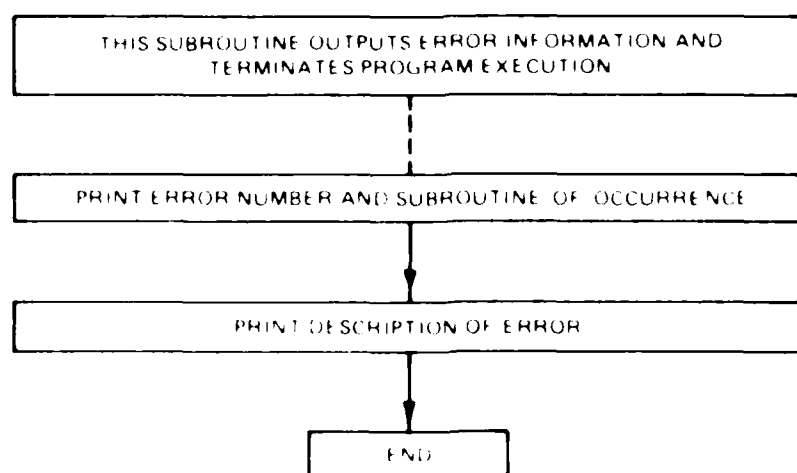


Figure 25. Flowchart for Subroutine ERROR

Table 10
ERROR Variables

| <u>Variable</u> | <u>Definition</u> |
|-----------------|--|
| CHK | In subroutine argument list; carries the value of the string which is in error. This is used only when a string is checked in the program for correspondence with an expected string |
| ERR | In subroutine argument list; carries the value of the error code number |
| KFILE | Output file code |
| SUBR | In subroutine argument list; carries the name of the subroutine in which the error occurred |
| XCHK1 | In subroutine argument list; carries the value of the string expected in the corresponding program check. If the program check was not a string comparison, value is zero |
| XCHK2 | In subroutine argument list; when program check has more than one possible expected string, XCHK2 carries the value of one of the strings expected in the program check. If no strings or one string was expected in program check, value is assigned zero |
| XCHK3 | Same as XCHK2, except that it is used when three possible values were expected in the program check. If zero, one, or two possible strings were expected, value is zero |

XREAD

72. Subroutine XREAD transfers information from the input file into working storage. The input file contains program control parameters, outlet characteristics, and reservoir profile data. As the input data are read, they are checked to ensure that the user has observed proper order and format. A general flowchart of the subroutine is shown in Figure 26. Table 11 lists descriptions of the variables used in the subroutine.

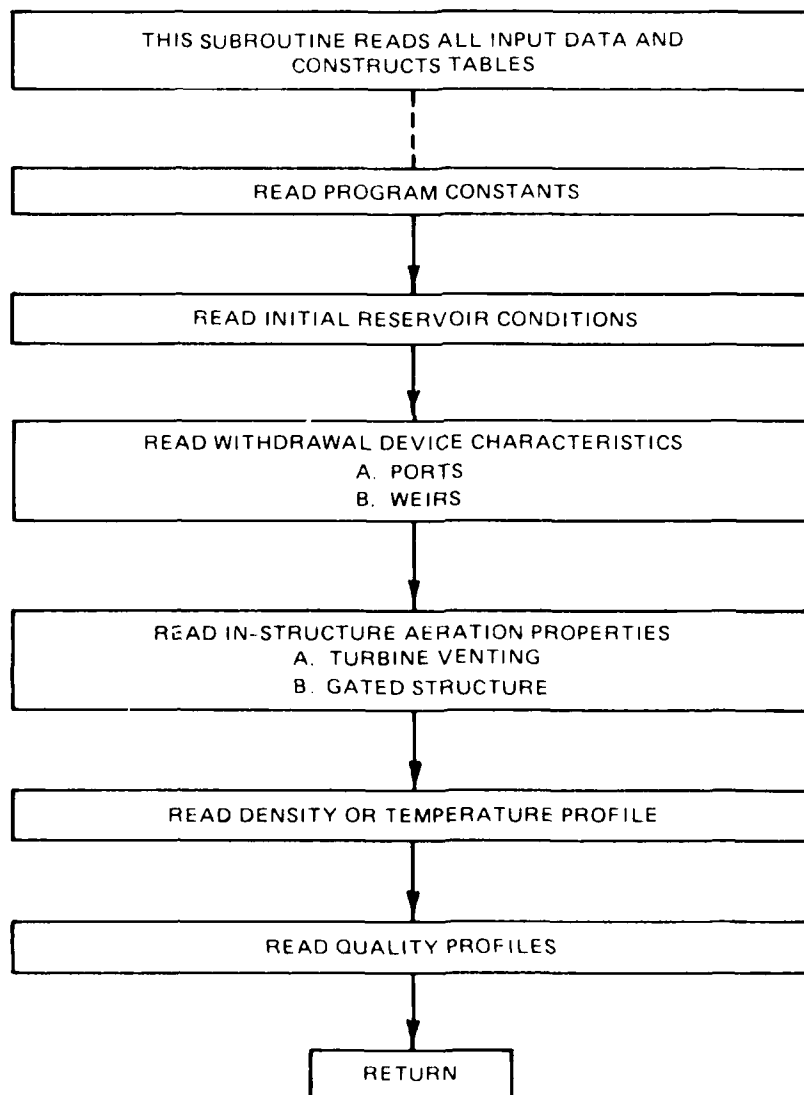


Figure 26. Flowchart for subroutine XREAD

Table 11
XREAD Variables

| Variable | Definition |
|------------|--|
| BOTTOM | Elevation of bottom of pool |
| CHECK | Assigned as first four characters encountered on a line in the user input data file |
| CHECK1 | Same function as CHECK |
| CHECK2 | Same function as CHECK |
| COEF | Discharge coefficient for free weir flow |
| DELZ | Layer thickness |
| DEN(M) | Density of layer M, g/cm ³ |
| DEPTH | Depth of pool |
| DUMMY(I) | Line of input from data file for echo print of input |
| DUMQUAL(K) | Working storage assigned to qualities during interpolation of a complete computational profile, appropriate units |
| DUMYQ(K) | Working storage assigned to height of qualities above bottom during interpolation of a complete completion profile |
| FLODUM(K) | Working storage assigned to port flow during ordering of ports from bottom to top |
| FLOW(K) | Release flow rate through the K th port |
| G | Gravitational acceleration |
| HDUM | Working storage for port horizontal dimension |
| HEADING(I) | Title of data set; up to 80 characters in length |
| HGT(I) | Percentage of layer I that is filled with water |
| HGTDUM(I) | Working storage assigned as port height above bottom; used during reordering of ports from bottom to top |
| IFILE | File code for input data file; equals 05 |
| INTER | Interval of layers to be printed in output |
| ISURF | Total number of layers in a profile |
| JFILE | File code for auxiliary use; value should usually be specified by user as 00 |
| KFILE | File code for output data file; equals 06 |
| NAMEQ(J,I) | Name of the I th water quality parameter |

(Continued)

(Sheet 1 of 4)

Table 11 (Continued)

| Variable | Definition |
|----------|--|
| MFILE | Temporarily assigned IFILE or JFILE value; used in echo-print operation |
| NP | Number of ports + 1; used during ordering of ports from top to bottom |
| NPORTS | Number of selective withdrawal ports not including a weir |
| NQUAL | Number of water quality parameters |
| NSETS | Number of data sets in the input file |
| NUMD | Total number of density values in density profile |
| NUMQ(I) | Total number of quality values in the I th quality parameter profile |
| NUMT | Total number of temperature values in temperature profile |
| PHDIM(K) | Horizontal dimension of port K |
| PHGT(K) | Height above bottom of the K th port center line |
| PVDIM(K) | Vertical dimension of port K |
| QAERA | Logical variable; true, consider DO uptake due to aeration through a gated structure outlet works; false, do not consider aeration |
| QCENT | Logical variable; true, temperatures are in degrees Centigrade; false, Fahrenheit |
| QDEN | Logical variable; true when density is input; if false, program develops density profile |
| QECHO | Logical variable; true for echo print of input data file; false for no echo print |
| QFIRST | Logical variable; true, XREAD has been called once by the main program; false, XREAD has not been called by the main program |
| QMETR | Logical variable; true when units are metric (SI); otherwise, false and units are English (non-SI) |
| QPLOT | Logical variable; true if line printer plot of density and total velocity profiles is desired; false if not desired |
| QPORT | Logical variable; true when ports are present as outlet devices; false if there are no ports |
| QQUAL | Logical variable; true if quality profiles will be entered; false if quality profiles will not be entered |

(Continued)

(Sheet 2 of 4)

Table 11 (Continued)

| Variable | Definition |
|-----------|--|
| QSUB | Logical variable; true for a submerged weir; false for a free weir |
| QTAB1 | Logical variable; true when profile data are input as one table; false when two tables are used: one for vertical locations and one for corresponding profile parameter values (see input description, Part V) |
| QTEMP | Logical variable; true when temperature profile is input; false otherwise |
| QTFUN | Logical variable; true when a tailwater elevation function will be used; false when not used |
| QUAL(I,M) | M th value for the I th quality parameter, appropriate units |
| QWEIR | Logical variable; true when a weir is included as an outlet device; false otherwise |
| SUBR | Subroutine name |
| SURFACE | Elevation of pool surface |
| TABTYP | When equal to 1, profile data will be input as one table; when equal to 2, data will be input as two tables (see input description, Part V) |
| TEMP(M) | Temperature value of layer M, degrees Centigrade or Fahrenheit |
| TITLE(I) | Identification title for input file; up to 80 characters in length |
| TWEL | Value of tailwater elevation |
| UNITS | When equal to CENT, temperature is specified in degrees Centigrade; when equal to FAHR, Fahrenheit degrees |
| VDIMDM(I) | Temporarily assigned value of PVDIM(K); used in port reordering algorithm |
| VDUM | Working storage for port vertical dimension |
| WRFLOW | Outflow quantity over weir |
| WRHGT | Weir crest height above bottom |
| WRLNG | Weir length |
| WRTYPE | Equal to SUBM for a submerged weir; equal to FREE for a free weir |
| WTHETA(K) | Withdrawal angle for port K |

(Continued)

(Sheet 3 of 4)

Table 11 (Concluded)

| Variable | Definition |
|----------|---|
| Y(I) | Height above bottom of the midpoint of layer I |
| YD(M) | Elevation, height above bottom or depth below surface of the M th density profile value |
| YQ(M) | Elevation, height above bottom or depth below surface of the M th quality profile value |
| YT(M) | Elevation, height above bottom or depth below surface of the M th temperature profile value |

All of the following variables are used to check for input errors and are assigned a character value equal to the four characters that follow the X.

| | | | | | | |
|-------|-------|-------|-------|-------|-------|-------|
| XANGL | XDENS | XFILE | XINTE | XPORT | XSURF | XWEIR |
| XBOTT | XDEPT | XFLOW | XLENG | XPRIN | XTABL | |
| XCENT | XELEV | XFREE | XMETR | XQUAL | XTEMP | |
| XCOEF | XENGL | XHDIM | XNUMB | XSTOP | XTHIC | |
| XDATA | XFAHR | XHEIG | XPLOT | XSUBM | XVDIM | |

Echo print

73. XREAD has an "echo-print" feature that is optional to the user (option commands are discussed in Part IV). The echo-print feature prints the entire input file to the output, thus allowing the user to see the input and output together. This feature, along with the error checks (given in Appendix D), provide the user with the capability to diagnose error problems in input.

Computational layers

74. XREAD develops the computational layers used in program calculations. The number of computational layers is determined by dividing the impoundment depth by the user-specified layer thickness.

AERATE

75. Subroutine AERATE accounts for the reaeration (DO uptake) of release water during flow through a gated-conduit outlet works. The subroutine determines the upstream oxygen deficit based on the flow-weighted average of DO in the release (calculated in subroutine OUTVEL). AERATE computes the downstream deficit based on the "energy dissipation" model outlined by Wilhelms and Smith (1981) and subsequently calculates the release DO concentration. Figure 27 shows the flowchart for subroutine AERATE. Table 12 lists descriptions of the subroutine variables.

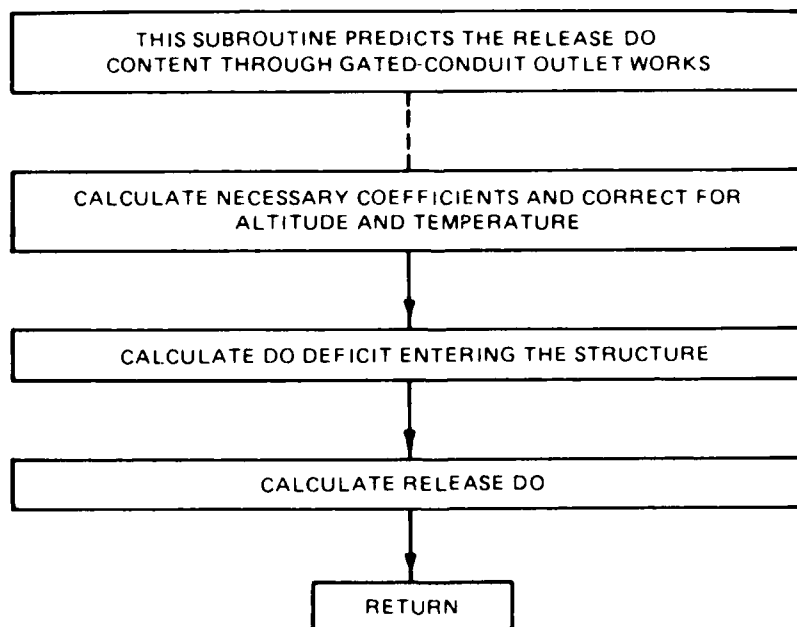


Figure 27. Flowchart for subroutine AERATE

Table 12
AERATE Variables

| <u>Variable</u> | <u>Definition</u> |
|-----------------|--|
| ALT | The elevation of the pool bottom |
| BOTTOM | The elevation of the pool bottom |
| C | Temperature-adjusted escape coefficient for oxygen |
| CSAT | Oxygen saturation concentration adjusted for altitude |
| C20 | Equals 0.045 if English (non-SI) units are used; 0.1476 if metric (SI) units are used |
| DELH | Elevation difference between the pool surface and the tailwater surface |
| DEPTH | Depth of the pool |
| DF | DO deficit exiting structure |
| DI | DO deficit entering structure |
| QAERA | Logical variable; true, consider DO uptake due to aeration through a gated-structure outlet works; false, do not consider uptake |
| QALOUT(1) | The outflow DO concentration (weighted average) that is adjusted by subrouting AERATE |
| QMETR | Logical variable; true when metric (SI) units are used; false when English (non-SI) units are used |
| TEMOUT | Outflow temperature (weighted average) |
| TWEL | Elevation of tailwater |

VENTING

76. Subroutine VENTING accounts for the DO uptake by release water if venting techniques are applied to turbine releases. VENTING is based on WES and Tennessee Valley Authority studies of Francis turbines which have shown that a maximum of 30-percent reduction of the initial (penstock) deficit is reasonable with turbine venting. Therefore, VENTING adjusts the flow-weighted average of DO in the release (as calculated in subroutine OJTVEL), to reflect a 30-percent reduction in the deficit. The results predicted by VENTING should be considered as a maximum DO uptake that can be achieved with venting. The reader is referred to Wilhelms (1984) and Wilhelms, Schneider, and Howington (1987) for additional details. Figure 28 is a flowchart of subroutine VENTING; descriptions of the subroutine variables are given in Table 13.

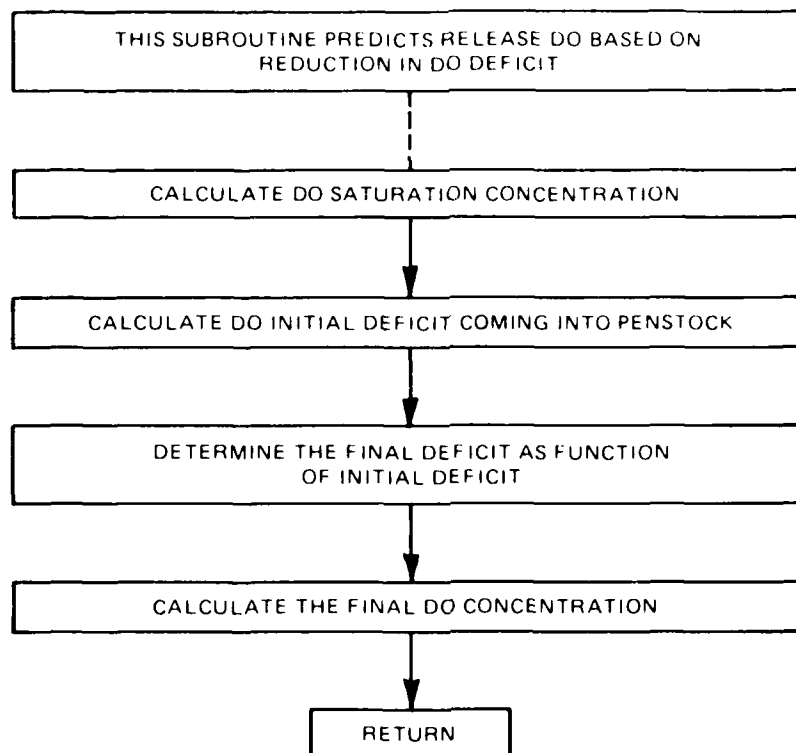


Figure 28. Flowchart for subroutine
VENTING

Table 13
VENTING Variables

| <u>Variable</u> | <u>Definition</u> |
|-----------------|--|
| ALT | Elevation of the pool bottom |
| BOTTOM | Elevation of the pool bottom |
| CSAT | Oxygen saturation concentration adjusted for altitude |
| DF | DO deficit of release water from structure |
| DI | DO deficit of water entering structure |
| QALOUT(1) | The flow-weighted average of the outflow DO concentration which is adjusted by subroutine VENTING |
| TEMOUT | The flow-weighted average of the outflow temperature |

PART IV: ASSUMPTIONS AND LIMITATIONS

77. In general, if the outlet and approach characteristics are simple, the results produced by SELECT will be accurate. However, if the characteristics are not of a simple nature, the assumptions inherent in the equations and theory of SELECT may be violated. The user should be aware of these assumptions and how they limit the accuracy of results. Thus, a listing of these assumptions is provided below. Violating these assumptions in a misapplication of the SELECT code will result in erroneous predictions. In some cases, more sophisticated modeling tools, such as multidimensional mathematical and physical models, may have to be employed to gain adequate results. In other cases, manipulation of the SELECT code itself might be possible. These solutions, however, must be considered on a site-specific basis. The user is encouraged to consult WES if any of the assumptions listed below are violated. Also included in the listing is a brief description of the limitation and effect of the assumption on SELECT predictions.

Geometry of Ports

78. Bohan and Grace (1969,1973) assumed that orifice geometries had no effect on the withdrawal zone. The dimensions of the orifice were small in comparison to the withdrawal zone thickness, e.g., point sink assumption. If this assumption is violated, SELECT will warn the user with an output statement but will continue to output results as if the assumption were valid.

Impoundment Width

79. The width of the impoundment in the region approaching the outlet works is assumed to be greater than the thickness of the withdrawal zone. Widths that are too narrow will cause lateral constrictions in the development of the withdrawal zone which will cause the extent of the withdrawal zone to increase beyond that predicted by

SELECT. Thus, if SELECT is run when this assumption is not valid, the calculated zone thickness may be less than the actual zone thickness.

Approach Path

80. The approach toward the outlet works is assumed free of obstruction. For example, a ridge at the bottom of the impoundment a short distance upstream from the outlet works could interfere with formation of the withdrawal zone. In such a case, the ridge may control withdrawal for one discharge with the outlet controlling for other discharges.

Approach Curvature

81. The approach toward the outlet works is assumed relatively straight. When the approach being modeled is curved, the withdrawal zone prediction may not be accurate.

Multiple Horizontal Ports

82. Use of SELECT in the past has shown that site-specific judgments need to be made concerning the modeling of multiple horizontal ports. The characteristics of withdrawal due to release through multiple horizontal ports remains largely undocumented. To illustrate, assume the existence of two ports that each withdraw as a point sink. It can be envisioned that, if the ports are far enough apart, the withdrawal zone of one port will not influence the withdrawal zone of the other. If the same ports are very near to each other, a withdrawal zone could be very closely approximated by the point sink equations by assuming that there is a single port with a flow rate equal to the combined magnitudes of the individual flow rates. The problems arise in the transition between ports that are hydrodynamically far apart or close together, because one port will affect the withdrawal characteristics of the others to some degree.

Weir Crest Above Thermocline

83. The equations used in the calculation of withdrawal limits for flow over a weir assume that the weir crest is above the thermocline. If this assumption is violated, the results from the program may be erroneous.

Hydraulic Integrity

84. SELECT assumes that it is hydraulically possible to proportion flows between multiple ports as input by the user. SELECT makes no check, for example, to ensure that multiple ports in the same wet well are not used. SELECT users should be aware of their responsibility to input operational scenarios which are viable for water quality control.

Simultaneous Port-Weir Operation

85. A port and a weir can be operated simultaneously only if each is releasing flow under its own control. For example, a spillway (weir) could be operated simultaneously with a water quality intake (port). Prediction of the withdrawal zone formed by a cofferdam (weir) directly in front of an outlet works is beyond the scope of SELECT. Such an operation would require more sophisticated modeling.

PART V: INPUT DATA

Descriptions

86. The following descriptions are presented to define the data that are needed as input for SELECT. All are listed in the order as they should appear in an input file. Formal descriptions of the input formats are given in Appendix A; example input files are given in Appendix B.

- a. TITLE - user-specified label to identify the global input file. The title should not exceed 80 characters in length (including spaces, numbers, and punctuation).
- b. DATA SETS - each must contain a heading, all port and weir information, and all necessary and desired parameter profiles. The ability to model several data sets in one execution saves the user time. That is, if the user intends to analyze several data sets, they can all be run in one program loading rather than several.
- c. PRINT INPUT - tells the program that the user desires an echo print (a copy of the input file) along with the output.
- d. HEADING - similar to TITLE except that it labels a single data set in an input file. Each data set in an input file must have a heading. The heading may be up to 80 characters in length (including spaces, numbers, and punctuation).
- e. METRIC OR ENGLISH - indicates which system of units to be used.

| <u>English (non-SI) Units</u> | <u>Metric (SI) Units</u> |
|-------------------------------|--------------------------|
| feet, seconds | meters, seconds |

Note: Densities are assumed to be in grams per cubic centimeter. The program default is English (non-SI) units.

- f. TABLES - the program accepts two different formats for table listings of any type of profile information. Whichever format is chosen, that format must be used for all tables in a data set.
 - (1) Format 1 - indicated by following the word TABLE on the input line by the number 1. This tells the program that the user wishes to enter profile data in the following way: elevation and the associated parameter values.
 - (2) Format 2 - indicated by following the word TABLE on the input line by any number other than 1. This tells the program that the user wishes to enter profile data in the following way: the elevation, followed by the parameter values on the same line until all elevations are entered, then the parameter values on the next line until all parameters are entered.

DD-A101 125

ENVIRONMENTAL AND WATER QUALITY OPERATIONAL STUDIES

2/3

SELECT: A NUMERICAL O. (U) ARMY ENGINEER WATERWAYS

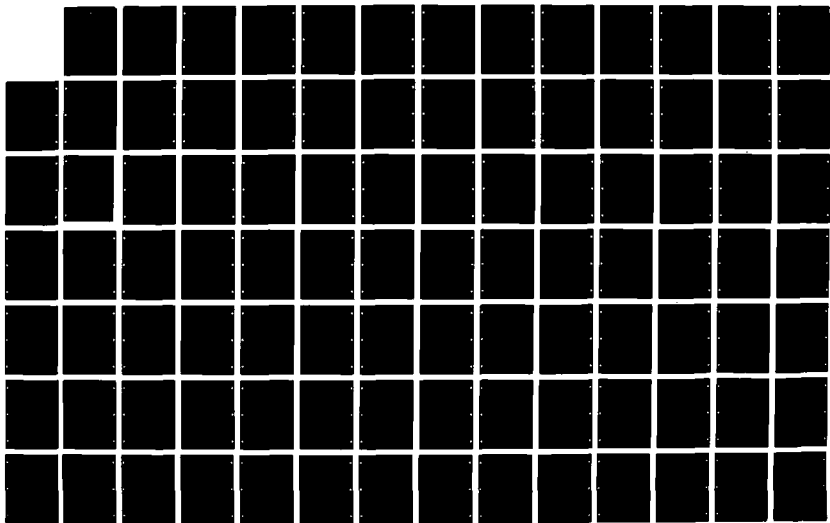
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UNCLASSIFIED

J E DAVIS ET AL. MAR 87 WES/IR/E-87-2

F/G 20/4

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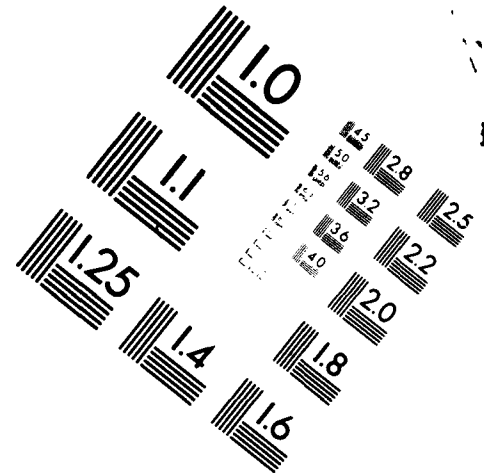
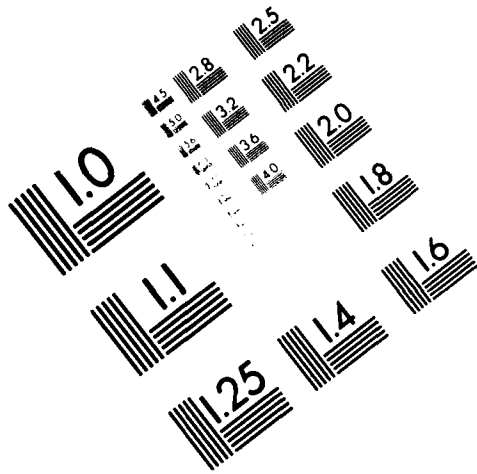
AIIM

Association for Information and Image Management

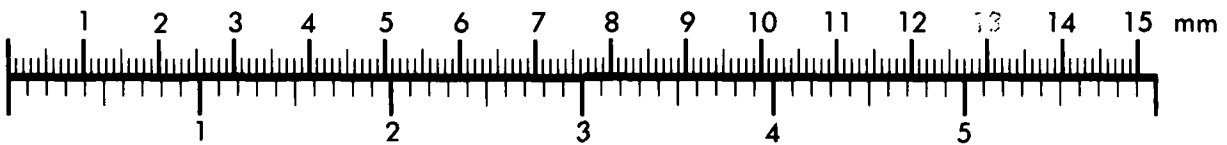
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Silver Spring, Maryland 20910

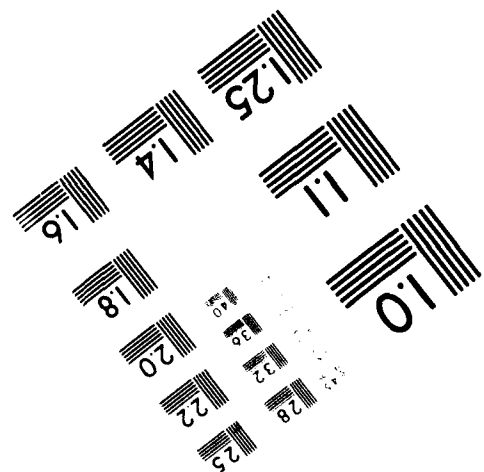
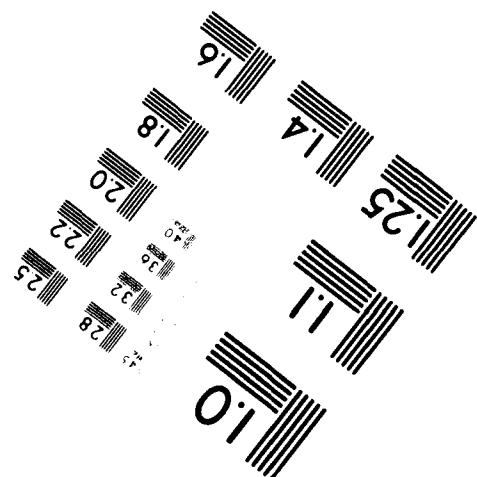
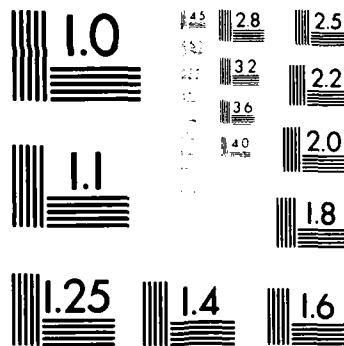
301/587-8202



Centimeter



Inches



MANUFACTURED TO AIIM STANDARDS

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PART V: INPUT DATA

Descriptions

86. The following descriptions are presented to define the data that are needed as input for SELECT. All are listed in the order as they should appear in an input file. Formal descriptions of the input formats are given in Appendix A; example input files are given in Appendix B.

- a. TITLE - user-specified label to identify the global input file. The title should not exceed 80 characters in length (including spaces, numbers, and punctuation).
- b. DATA SETS - each must contain a heading, all port and weir information, and all necessary and desired parameter profiles. The ability to model several data sets in one execution saves the user time. That is, if the user intends to analyze several data sets, they can all be run in one program loading rather than several.
- c. PRINT INPUT - tells the program that the user desires an echo print (a copy of the input file) along with the output.
- d. HEADING - similar to TITLE except that it labels a single data set in an input file. Each data set in an input file must have a heading. The heading may be up to 80 characters in length (including spaces, numbers, and punctuation).
- e. METRIC OR ENGLISH - indicates which system of units to be used.

English (non-SI) Units

feet, seconds

Metric (SI) Units

meters, seconds

Note: Densities are assumed to be in grams per cubic centimeter. The program default is English (non-SI) units.

- f. TABLES - the program accepts two different formats for table listings of any type of profile information. Whichever format is chosen, that format must be used for all tables in a single data set.
 - (1) Format 1 - indicated by following the word TABLES on the input line by the number 1. This tells the program that the user wishes to enter profile data as one value of elevation and the associated parameter value per line.
 - (2) Format 2 - indicated by following the word TABLES on the input line by any number other than 1. This tells the program that the user wishes to enter data in the following way the elevations will be listed eight values per line until all elevations are entered; then the associated parameter values will be listed eight values per line until all parameter values are entered. The positions of

the parameter values on a line must match the line positions of the associated elevations.

- g. THICKNESS - indicates the user-desired thickness of each computational layer. It is suggested that the thickness not exceed 5 ft (or 1.5 m) in order to preserve definition of the input profiles. The computational layer has parameter values assigned to it, such as velocity, density, temperature, and water quality. Since the parameter value is taken as constant throughout the layer, any variation in the actual parameter value inside the layer is neglected. Thus, in order to prevent any gross errors from occurring due to the differences between the actual and discretized profiles, a layer thickness of no more than 5 ft should be used. The layer thickness limit may vary from project to project.
- h. INTERVAL - determines how often computational layer parameter values are to be output--every layer, every other layer, etc. An interval of "1" will output values for every layer. An interval of "2" will output values for every second layer, and so on. An interval of "0" will not be accepted by the program.
- i. SURFACE - the value of the surface elevation. This must be input as an elevation above the user-defined datum.
- j. BOTTOM - the value of the bottom elevation. This must be input as an elevation above the user-defined datum.
- k. PORTS - identifies the number of operating ports to be modeled by the program in a single data set. The number of operating ports is limited to five by the program dimensions. Multiple ports operating at the same elevation and within close lateral proximity should be combined into a single port for input. Otherwise, the extreme withdrawal zone interaction will likely result in underprediction of the withdrawal zone thickness by the program.
- l. VDIM - the value of the vertical dimension of the port. If more than one port is being modeled, the vertical dimensions for all of the ports must be listed on one line. They may be listed from the bottom port to the top port, or vice versa.
- m. HDIM - the value of the horizontal dimension of the port. If more than one port is modeled, the horizontal dimensions of all the ports must be listed on one line. They may be listed from the bottom port to the top port, or vice versa; however, the ordering must match the ordering of VDIM.
- n. PORT ELEVATION - the vertical port positions in the impoundment may be given as elevation above a user-defined datum, as depth below the surface, or as height above the bottom. Elevation (or depth or height) values for multiple ports must be listed on one line. The ordering may be from the bottom port to the top port, or vice versa. Again, however, the ordering must match the ordering used for VDIM.

- q. FLOW - the value of the flow rate through a port or over a weir. If multiple ports are modeled, the flow rates for all the ports must be listed on one line. The ordering of the values may be from the top port to the bottom port, or vice versa. This ordering must also match the ordering of VDIM.
- p. WITHDRAWAL ANGLE - the effective angle of withdrawal in the horizontal plane of the port. The withdrawal angles for all ports must be entered on one line and may be ordered from bottom port to top port, or vice versa. The ordering must match that of VDIM.
- q. WEIR - indicates that a weir is to be modeled by the program.
- r. WEIR TYPE - indicates whether the weir is a free weir (discharge unaffected by downstream pool) or a submerged weir (discharge affected by downstream pool).
- s. COEFFICIENT - the weir coefficient to be used if the weir is not considered submerged.
- t. WEIR LENGTH - the length of the crest of the weir.
- u. WEIR CREST ELEVATION - the elevation above the user-defined datum, depth below the surface, or height above the bottom of the weir crest.
- v. TURBINE VENTING - indicates that the improvement in DO content due to turbine aeration should be taken into account. The improvement is based on a 30 percent decrease in the penstock DO deficit. A DO water quality profile must be part of the input file if this command is used.
- w. GATED STRUCTURE - indicates that the change in DO content due to aeration through gated-conduit structures should be taken into account. The amount of change is approximated based on results of Wilhelms and Smith (1981). A DO water quality profile must be part of the input file if this command is used.
- x. TAILWATER ELEVATION - indicates that the tailwater elevation is entered. The tailwater elevation must be used only if the GATED STRUCTURE command is used.
- y. TAILWATER FUNCTION - often the tailwater cannot be given directly but is a function of the discharge. In that case, a function subprogram must be written and appended to the SELECT code. This command may be used only if the GATED STRUCTURE command is used. For assistance with this input, the user should contact personnel of the Reservoir Water Quality Branch of the WES Hydraulics Laboratory.

Profile Formats

87. Input profile formats for a single data set must match the format specified on the "TABLES" card.

- a. DENSITY - density profile is necessary for the operation of SELECT. If a density profile is not available, a temperature profile must be input from which the program can generate densities.
- b. OTHER PARAMETERS - water quality parameter profiles are necessary if release water quality predictions are desired. If the GATED STRUCTURE or TURBINE VENTING input commands are used, a DO profile must be the first water quality profile listed after the density and/or temperature profiles. If a density profile is input to define reservoir stratification (to account for suspended or dissolved solids) and release temperature is of interest, the temperature profile may be input as a water quality parameter. Up to four other water quality parameter profiles may be entered.

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APPENDIX A: INPUT FORMAT DESCRIPTION

Notes on Input Format

1. CARD refers to card image input if disc files or magnetic tapes are used as input devices.
2. The format code following the CARD number is the format by which the input line of data will be read. The input must match the fields of the appropriate format.
3. Following the CARD-FORMAT line is the list of variables used to store the input data. They are listed in the order by which they are entered. Following each variable name is the expected input for the first word(s) of the input line. When several expected input phrases are listed, only one is chosen.
4. Each time more than one card is required to input profile values, the remaining input cards will need to be renumbered to reflect the extra cards used. For example, when profile data are to be entered as one elevation value and one parameter value per line, such as CARD #24 when TABTYP = 1 , more than one profile data card will be required to define the profile. If, as a simple case, it is assumed four profile data input cards will be necessary, they would be numbered CARD #24, CARD #25, CARD #26, and CARD #27. The remaining input cards should be resequenced beginning with CARD #28.
5. Be sure that all input data units are consistent with the system of units specified on CARD #05. The exception to this is the units for density, which should always be entered as grams per cubic centimeter.
6. There must be a STOP statement at the end of each data set.

SELECT Program-Input Format Description

- CARD #01 FORMAT (20A4)
1. TITLE - An arbitrary title not to exceed 80 characters in length
- CARD #02 FORMAT (A4, 6X, 14I5)
1. CHECK - "DATA"
2. NSETS - Number of data sets in input file
- CARD #03 FORMAT (20A4)
1. CHECK - A) "PRINT INPUT" - Echo print input
 B) "(ANYTHING ELSE)" - No echo print
- CARD #04 FORMAT (20A4)
1. HEADING - An arbitrary descriptive heading for the simulation,
 not to exceed 80 characters in length
- CARD #05 FORMAT (20A4)
1. CHECK - A) "METRIC" - Input and output are in Metric (SI) units
 B) "ENGLISH" - Input and output are in English (non-SI)
 units
- CARD #06 FORMAT (A4, 6X, 14I5)
1. CHECK - "TABLES"
2. TABTYP - A) "1" - Program reads profile input data in a table of
 one value of elevation, depth below the surface, or
 height above the bottom, and a corresponding value
 of density, temperature, or quality per line.
 B) "(ANY OTHER NUMBER)" - Program reads profile data as
 a table of all the values (eight per line) of eleva-
 tion, depth below the surface, or height above the
 bottom followed by a table of all the values of the
 corresponding density, temperature, or quality.
- CARD #07 FORMAT (A4, 6X (7F10.0))
1. CHECK - "THICKNESS"
2. DELZ - Thickness of each computational layer (feet or meters)
- CARD #08 FORMAT (A4, 6X, 14I5)
1. CHECK - "INTERVAL"
2. INTER - The interval used to select layer information for
 printout
- CARD #09 FORMAT (A4, 6X (7F10.0))
1. CHECK - "SURFACE"
2. SURFACE - Elevation of the water surface (feet or meters)
- CARD #10 FORMAT (A4, 6X (7F10.0))
1. CHECK - "BOTTOM"
2. BOTTOM - Elevation of the lake bottom (feet or meters)

- CARD #11 FORMAT (A4, 6X, 14I5)
1. CHECK - A) "PORT"
 B) "WEIR"
2. NPORTS - Number of ports (not applicable if weir only)

If "WEIR" was specified on Card #11, go to Card #18; otherwise continue.

- CARD #12 FORMAT (A4, 6X (7F10.0))
1. CHECK - "VDIM"
2. (PVDIM(K), K=1, NPORTS) - Vertical dimensions of the ports
 (feet or meters)

- CARD #13 FORMAT (A4, 6X (7F10.0))
1. CHECK - "HDIM"
2. (PHDIM(K), K=1, NPORTS) - Horizontal dimensions of the ports
 (feet or meters)

- CARD #14 FORMAT (A4, 6X (7F10.0))
1. CHECK - A) "ELEVATION"
 B) "DEPTH"
 C) "HEIGHT"
2. (PHGT(K), K=1, NPORTS) - Center-line elevation, depth or height
 of the ports (feet or meters)

- CARD #15 FORMAT (A4, 6X (7F10.0))
1. CHECK - "FLOW"
2. (FLOW(K), K=1, NPORTS) - Flow through each of the ports
 (cubic feet per second or cubic meters per second)

- CARD #16 FORMAT (A4, 6X (7F10.0))
1. CHECK - "ANGLE"
2. (WTHETA(K), K=1, NPORTS) - The withdrawal angle for each port
 (radians)

If "PORTS" was specified on Card #11 and a weir is to be modeled also, used
CARDS #17, #18, and #19; otherwise omit them.

- CARD #17 FORMAT (A4, 6X, 14I5)
1. CHECK - "WEIR"

- CARD #18 FORMAT (A4, 6X, 14I5)
1. CHECK - A) "FREE"
 B) "SUBMERGED"

If "SUBMERGED" was specified on Card #18, omit Card #19; otherwise
continue.

- CARD #19 FORMAT (A4, 6X (7F10.0))
1. CHECK - "COEF"
2. COEF - Coefficient of discharge for free weir flow. These
 coefficients should be 3.0, 3.33, or 4.10.

July 1992

CARD #20 FORMAT (A4, 6X (7F10.0))

1. CHECK - "LENGTH"
2. WRLNG - Length of the weir crest (feet or meters)

CARD #21 FORMAT (A4, 6X (7F10.0))

1. CHECK - A) "ELEVATION"
B) "DEPTH"
C) "HEIGHT"
2. WRHGT - Elevation, depth, or height of the weir crest
(feet per second or meters per second)

CARD #22 FORMAT (A4, 6X (7F10.0))

1. CHECK - "FLOW"
2. WRFLOW - Flow over the weir (cubic feet per second or cubic meters per second)

Optional CARD FORMAT (20A4)

1. CHECK - A) "TURBINE VENTING" - If turbine venting is to be modeled
B) "GATED STRUCTURE" - If aeration due to gated conduit is to be modeled

If "GATED STRUCTURE" is entered, so must the following optional card.

Optional CARD FORMAT (A4, 6X, A4 6X, (6F10.0))

1. CHECK1 - "TAILWATER"
2. CHECK2 - A) "ELEVATION" - If tailwater elevation
B) "FUNCTION" - If tailwater function
3. TWEL - Value of the tailwater elevation

CARD #23 FORMAT (A4, 6X, A4, 6X, 12I5)

1. CHECK1 - "NUMBER OF"
2. CHECK2 - A) "DENSITIES"
B) "TEMPS"
3. NUMD - A) Number of density values in profile, or
B) Number of temperature values in profile

If "TEMPS" was specified on Card #23, go to Card #29; otherwise continue.

If TABTYP EQ. 1 (Card #06)

CARD #24 FORMAT (A4, 6X, A4)

- ```

1. CHECK1 - A) "ELEVATION"
 B) "DEPTH"
 C) "HEIGHT"
2. CHECK2 - "DENSITIES"

```

CARD #25    FORMAT (2F10.0)

1. (YD(M), DEN(M), M-1, NUMD) - Values of elevation, depth, or height (feet or meters) and the corresponding values of density (grams per cubic centimeter)

CARD #26 and #27 not used

An adequate number of cards containing the profile elevation and density values using the above format are required at this point. The remaining input cards should be renumbered to continue in sequence.

If TABTYP. NE. 1 (Card #06)

CARD #24   FORMAT (20A4)  
          CHECK - A) "ELEVATION"  
                  B) "DEPTH"  
                  C) "HEIGHT"

CARD #25   FORMAT (8F10.0)  
          1. (YD(M), M=1, NUMD) - Values of elevation, depth, or height  
              corresponding with density values to be input (feet or meters)

An adequate number of cards containing profile elevation values using the above format are required at this point. The remaining input cards should be renumbered to continue in sequence.

CARD #26   FORMAT (A4, 6X, 14I5)  
          1. CHECK - "DENSITY"

CARD #27   FORMAT (8F10.0)  
          1. (DEN(M), M=1, NUMD) - Values of density corresponding to the  
              data on Card #25 (grams per cubic centimeters)

An adequate number of cards containing profile density values using the above format are required at this point. The remaining input cards should be renumbered to continue in this sequence.

CARD #28   FORMAT (A4, 16X, 12I5)  
          1. CHECK - A) "NUMBER OF TEMPS"  
                  B) "QUALITIES"  
                  C) "STOP" - Read sequence stops  
          2. NUMT - Number of temperature if "NUMBER OF TEMPS" is entered

If "STOP" was specified on Card #28, go to last line of this description (page A8).

If "QUALITIES" was specified on Card #28, go to Card #35.

If "NUMBER OF TEMPS" was specified on Card #28, continue.

CARD #29   FORMAT (A4, 16X, A4)  
          1. CHECK - A) "TEMPERATURE DEGREES"  
                  2. UNITS - A) "FAHRENHEIT"  
                              B) "CENTIGRADE"

If TABTYP EQ. 1 (Card #06)

Instruction Report E-87-2  
July 1992

CARD #30   FORMAT (A4, 6X, A4)  
1.   CHECK1 - A) "ELEVATION"  
              B) "DEPTH"  
              C) "HEIGHT"  
2.   CHECK2 - "TEMPERATURE"

CARD #31   FORMAT (2F10.0)  
1.   (YT(M), TEMP(M), M=1, NUMT) - Values of elevation, depth, or height (feet or meters) and the corresponding values of temperature (units specified on Card #29)

CARD #32 and #33 not used

An adequate number of cards containing the profile elevation and temperature values using the above format are required at this point. The remaining input cards should be renumbered to continue in this sequence.

If TABTYP NE. 1 (Card #06)

CARD #30   FORMAT (20A4)  
1.   CHECK - A) "ELEVATION"  
              B) "DEPTH"  
              C) "HEIGHT"

CARD #31   FORMAT (8F10.0)  
1.   (TY(M), M=1, NUMT) - Values of elevation, depth, or height corresponding with temperature values to be input (feet or meters)

An adequate number of cards containing profile elevations using the above format are required at this point. The remaining input cards should be renumbered to continue in sequence.

CARD #32   FORMAT (20A4)  
1.   CHECK - "TEMPERATURE"

CARD #33   FORMAT (8F10.0)  
1.   (TEMP(M), M=1, NUMT) - Values of temperature corresponding to the data on Card #31 (units specified on Card #30)

An adequate number of cards containing profile temperatures using the above format are required at this point. The remaining input cards should be renumbered to continue in sequence.

CARD #34   FORMAT (A4, 6X, 14I5)  
1.   CHECK - A) "QUALITIES"  
              B) "STOP" - Read sequence stops  
2.   NQUAL - Number of quality parameters

If STOP was specified on CARD #34, go to last line of this description (page A8). If QUALITIES was specified on CARD #34, continue.

CARD #35 FORMAT (A4, 6X, 5A4, I5)

1. CHECK - "NUMBER OF"
2. (NAME(NM, I) NM=1,5) - Name of the I<sup>th</sup> quality parameter (not to exceed 20 characters)
3. NUMQ(I) - Number of quality(I) values

If TABTYP EQ. 1 (Card #06)

CARD #36 FORMAT (A4, 6X, A4)

1. CHECK - A) "ELEVATION"  
B) "DEPTH"  
C) "HEIGHT"

CARD #37 FORMAT (2F10.0)

1. (YQ(I,M), QUAL(I,M), M=1, NUMQ(I)) - Values of elevation, depth, or height (feet or meters) and the corresponding values of the I<sup>th</sup> quality parameter (appropriate units)

CARDS #38 and #39 not used

An adequate number of cards containing the profile elevation and quality values using the above format are required at this point. The remaining input cards should be renumbered to continue in sequence.

If TABTYP NE. 1 (Card #06)

CARD #36 FORMAT (20A4)

1. CHECK - A) "ELEVATION"  
B) "DEPTH"  
C) "HEIGHT"

CARD #37 FORMAT (8F10.0)

1. (YQ(I,M) M=1, NUMQ(I)) - Values of elevation, depth, or height corresponding with the I<sup>th</sup> quality parameter values to be input (feet or meters)

An adequate number of cards containing the profile elevations using the above format are required at this point. The remaining input cards should be renumbered to continue in sequence.

CARD #38 FORMAT (20A4)

1. CHECK - Name of the I<sup>th</sup> quality parameter

CARD #39 FORMAT (8F10.0)

1. (QUAL(I,M), M=1, NUMQ(I)) - Values of the I<sup>th</sup> quality parameter corresponding to the data on Card #37 (appropriate units)

An adequate number of cards containing the profile qualities using the above format are required at this point. The remaining input card should be renumbered to continue in sequence.

If there are more water quality profiles, repeat CARDS #36-39 for each additional water quality parameter.

Instruction Report E-87-2  
July 1992

CARD #40 FORMAT (20A4)

1. CHECK - "STOP" - Stops read sequence

If there are more data sets, repeat CARDS #04-40 for each additional data set.

APPENDIX B: INPUT EXAMPLES

1. The following are examples of simple input files. They are presented to help clarify the structure of an input file.
2. The impoundment being modeled has a pool that is 100 ft deep, with the elevation of the bottom taken as zero or datum.

Example File 1

3. Example File 1 models a single 5- by 5-ft port whose center line is located 20 ft below the pool surface. The port has a withdrawal angle of 180 deg (3.14 rad) and releases a flow rate of 100 cfs.
4. The density profile needed to run SELECT will be generated by the program using the given temperature profile. The only water quality parameter modeled is temperature.
5. For the computations, the pool will be divided into layers 3 ft thick each. The printout interval for layer information will be at every layer (INTERVAL = 01).

```
ANONYMOUS LAKE EXAMPLE
DATA SETS 01
PRINT INPUT
EXAMPLE FOR INPUT/OUTPUT USING PORT
ENGLISH
TABLE 01
THICKNESS 3.0
INTERVAL 01
SURFACE 100.0
BOTTOM 0.0
PORT 1
VDIM 5.0
HDIM 5.0
DEPTH 20.0
FLOW 100.0
ANGLE 3.14
NUMBER OF TEMP 12
TEMPERATURE DEGREES CENTIGRADE
HEIGHT TEMP
 97.6 28.9
 90.0 28.2
 80.0 27.0
 69.8 26.0
 65.0 24.9
 60.0 23.0
 57.6 20.0
 53.9 18.5
 50.0 17.5
 40.0 16.7
 31.2 15.9
 20.0 15.0
STOP
```

Example File 2

6. Example File 2 models the same thing as Example File 1 with a few variations. One variation is that another port vertically separated from the first port is to be modeled. The two ports are considered to be operating simultaneously and independently. The second port is located 50 ft below the pool surface and has the same dimensions and withdrawal characteristics as the first port.

7. The presence of the dissolved oxygen (DO) profile following the temperature profile indicates that the user wishes to know the release DO concentration as well as temperature. The calculation of release DO will include DO uptake due to gated-conduit reaeration because the GATED STRUCTURE command is present following the port information in the input file.

|                                     |      |     |
|-------------------------------------|------|-----|
| ANONYMOUS LAKE EXAMPLE              | 50.3 | 0.3 |
| DATA SETS 01                        | 40.6 | 0.2 |
| PRINT INPUT                         | 30.0 | 0.2 |
| EXAMPLE FOR INPUT/OUTPUT USING PORT | 21.7 | 0.1 |
| ENGLISH                             | 15.4 | 0.0 |
| TABLE 01                            | STOP |     |
| THICKNESS 3.0                       |      |     |
| INTERVAL 01                         |      |     |
| SURFACE 100.0                       |      |     |
| BOTTOM 0.0                          |      |     |
| PORT 2                              |      |     |
| VDIM 5.0 5.0                        |      |     |
| HDIM 5.0 5.0                        |      |     |
| DEPTH 50.0 20.0                     |      |     |
| FLOW 100.0 100.0                    |      |     |
| ANGLE 3.14 3.14                     |      |     |
| GATED STRUCTURE                     |      |     |
| TAILWATER ELEVATION 15.9            |      |     |
| NUMBER OF TEMP 12                   |      |     |
| TEMPERATURE DEGREES CENTIGRADE      |      |     |
| HEIGHT TEMP                         |      |     |
| 97.6 28.9                           |      |     |
| 90.0 28.2                           |      |     |
| 80.0 27.0                           |      |     |
| 69.8 26.0                           |      |     |
| 65.0 24.8                           |      |     |
| 60.0 23.0                           |      |     |
| 57.6 20.0                           |      |     |
| 53.9 18.5                           |      |     |
| 50.0 17.5                           |      |     |
| 40.8 16.7                           |      |     |
| 31.2 15.9                           |      |     |
| 20.0 15.0                           |      |     |
| QUALITIES 1                         |      |     |
| NUMBER OF DISSOLVED OXYGEN 13       |      |     |
| HEIGHT DISSOLVED OXYGEN             |      |     |
| 95.6 3.2                            |      |     |
| 90.2 3.2                            |      |     |
| 84.9 3.1                            |      |     |
| 78.7 3.0                            |      |     |
| 73.4 2.1                            |      |     |
| 69.5 1.8                            |      |     |
| 61.0 1.3                            |      |     |
| 58.4 0.5                            |      |     |

Example File 3

8. Example File 3 models a weir. The weir is the submerged type with its crest 65 ft off the bottom. It is 100 ft in length and has a total flow rate of 200 cfs over its crest.

9. The input file dictates that the pool should be divided into layers that are 3 ft thick and that the output data be given at every layer (INTERVAL = 01). As in Example File 2, the temperature and DO concentration of the release are desired. There is no option for DO calculations based on reaeration through the outlet works for weir flow.

```

ANONYMOUS LAKE EXAMPLE
DATA SETS 01
PRINT INPUT
EXAMPLE FOR INPUT/OUTPUT USING WEIR
ENGLISH
TABLE 01
THICKNESS 3 0
INTERVAL 01
SURFACE 100.0
BOTTOM 0 0
WEIR
SUBMERGED
LENGTH 100.
HEIGHT 65.0
FLOW 200.0
NUMBER OF TEMP 12
TEMPERATURE DEGREES CENTIGRADE
HEIGHT TEMP
 97.6 28.9
 90.0 28.2
 80.0 27.0
 69.8 26.0
 65.0 24.9
 60.0 23.0
 57.6 20.0
 53.9 18.5
 50.0 17.5
 40.0 16.7
 31.2 15.9
 20.0 15.0
QUALITIES 1
NUMBER OF DISSOLVED OXYGEN 13
HEIGHT DISSOLVED OXYGEN
 95.6 3.2
 90.2 3.2
 84.9 3.1
 78.7 3.0
 73.4 2.1
 69.5 1.8
 61.0 1.3
 58.4 0.5
 50.3 0.3
 40.6 0.2
 30.0 0.2
 21.7 0.1
 15.4 0.0
STOP

```

Example File 4

10. Example File 4 is an input file made up of Example Files 1 and 3. In other words, it is one input file containing two data sets. It is important to realize that this data file format will not cause the program to model the port and the weir simultaneously; rather, it will model the port only and produce output. Then it will model the weir only and produce output.

11. This technique of appending data sets saves time in loading and reloading the program for consecutive runs.

```

ANONYMOUS LAKE EXAMPLE
DATA SETS 02
PRINT INPUT
EXAMPLE FOR INPUT/OUTPUT USING PORT
ENGLISH
TABLE 01
THICKNESS 3 0
INTERVAL 01
SURFACE 100 0
BOTTOM 0 0
PORT 1
VDIM 5 0
HDIM 5 0
DEPTH 20 0
FLOW 100 0
ANGLE 3 14
NUMBER OF TEMP 12
TEMPERATURE DEGREES CENTIGRADE
HEIGHT TEMP
 97 6 28 9
 90 0 28 2
 80 0 27 0
 69 8 26 0
 65 0 24 9
 60 0 23 0
 57 6 20 0
 53 9 18 5
 50 0 17 5
 40 0 16 7
 31 2 15 9
 20 0 15 0

```

```

STOP
EXAMPLE FOR INPUT/OUTPUT USING WEIR
ENGLISH
TABLE 01
THICKNESS 3 0
INTERVAL 01
SURFACE 100 0
BOTTOM 0 0
WEIR
SUBMERGED
LENGTH 100
HEIGHT 65 0
FLOW 100 0
NUMBER OF TEMP 12
TEMPERATURE DEGREES CENTIGRADE
HEIGHT TEMP
 97 6 28 9
 90 0 28 2
 80 0 27 0
 69 8 26 0
 65 0 24 9

```

```

60 0 23 0
57 6 20 0
53 9 18 5
50 0 17 5
40 0 16 7
31 2 15 9
20 0 15 0
QUALITIES 1
NUMBER OF DISSOLVED OXYGEN 13
HEIGHT DISSOLVED OXYGEN
 95 6 3 2
 90 2 3 2
 84 9 3 1
 78 7 3 0
 73 4 2 1
 69 5 1 8
 61 0 1 3
 58 4 0 5
 50 3 0 3
 40 6 0 2
 30 0 0 2
 21 7 0 1
 15 4 0 0

```

STOP

## APPENDIX C: OUTPUT EXAMPLE

1. This appendix presents SELECT output for the fourth example input file in Appendix B. This output is divided as follows:

- a. Listing of the input file. In this example, the PRINT INPUT command was included in the input file. If the command is omitted from the input file, no listing of the input file is given.
- b. Summary of the output results. The summary includes the title of the input file, the title of the data set to which the results pertain, the units used for computations, each outlet's dimensions and flow rate, the total flow rate from all outlets, the locations of the upper and lower withdrawal limits, and the total outflow concentration of all water quality parameters modeled.
- c. Tabular listing of flow rates, velocities, and water quality parameter concentrations, given at layer center-line elevations. The interval between the layers at which information is given depends on the INTERVAL command listed in the input file. An interval of "1" will list layer information at every layer, an interval of "2" will list layer information at every other layer, and so on.
- d. Line-printer plot of the velocity and density profile. The data points on the plot coincide with the data in each of the layers. All layers are included in this plot.

2. If the user chooses to use multiple data sets in one input file, as in this example, the results from each data set will be listed individually and output one after the other in the results.

```
1000 ****ANONYMOUS LAKE EXAMPLE
1010 ****DATA SETS 02
1020 ****PRINT INPUT
1030 ****EXAMPLE FOR INPUT/OUTPUT USING PORT
1040 ****ENGLISH
1050 ****TABLE 01
1060 ****THICKNESS 3.0
1070 ****INTERVAL 01
1080 ****SURFACE 100.0
1090 ****BOTTOM 0.0
1100 ****PORT 1
1110 ****VDIM 5.0
1120 ****HDM 5.0
1130 ****DEPTH 20.0
1140 ****FLOW 100.0
1150 ****ANGLE 3.14
1160 ****NUMBER OF TEMP 12
1170 ****TEMPERATURE DEGREES CENTIGRADE
1180 ****HEIGHT TEMP
1190 *** 97.6 28.9
1200 *** 90.0 28.2
1210 *** 80.0 27.0
1220 *** 69.8 26.0
1230 *** 65.0 24.9
1240 *** 60.0 23.0
1250 *** 57.6 20.0
1260 *** 53.9 18.5
1270 *** 50.0 17.5
1280 *** 40.8 16.7
1290 *** 31.2 15.9
1300 *** 20.0 15.0
1310 ****STOP
1320 ****EXAMPLE FOR INPUT/OUTPUT USING WEIR
1330 ****ENGLISH
1340 ****TABLE 01
1350 ****THICKNESS 3.0
1360 ****INTERVAL 01
1370 ****SURFACE 100.0
```

|      |                                   |           |
|------|-----------------------------------|-----------|
| 1380 | ***BOTTOM                         | 0.0       |
| 1390 | ***WEIR                           |           |
| 1400 | ***SUBMERGED                      |           |
| 1410 | ***LENGTH                         | 100.      |
| 1420 | ***HEIGHT                         | 65.0      |
| 1430 | ***FLOW                           | 100.0     |
| 1440 | ***NUMBER OF TEMP                 | 12        |
| 1450 | ***TEMPERATURE DEGREES CENTIGRADE |           |
| 1460 | ***HEIGHT TEMP                    |           |
| 1470 | ***                               | 97.6 28.9 |
| 1480 | ***                               | 90.0 28.2 |
| 1490 | ***                               | 80.0 27.0 |
| 1500 | ***                               | 69.8 26.0 |
| 1510 | ***                               | 65.0 24.9 |
| 1520 | ***                               | 60.0 23.0 |
| 1530 | ***                               | 57.6 20.0 |
| 1540 | ***                               | 53.9 18.5 |
| 1550 | ***                               | 50.0 17.5 |
| 1560 | ***                               | 40.8 16.7 |
| 1570 | ***                               | 31.2 15.9 |
| 1580 | ***                               | 20.0 15.0 |
| 1590 | ***QUALITIES                      | 1         |
| 1600 | ***NUMBER OF DISSOLVED OXYGEN     | 13        |
| 1610 | ***HEIGHT DISSOLVED OXYGEN        |           |
| 1620 | ***                               | 95.6 3.2  |
| 1630 | ***                               | 90.2 3.2  |
| 1640 | ***                               | 84.9 3.1  |
| 1650 | ***                               | 78.7 3.0  |
| 1660 | ***                               | 73.4 2.1  |
| 1670 | ***                               | 69.5 1.8  |
| 1680 | ***                               | 61.0 1.3  |
| 1690 | ***                               | 58.4 0.5  |
| 1700 | ***                               | 50.3 0.3  |
| 1710 | ***                               | 40.6 0.2  |
| 1720 | ***                               | 30.0 0.2  |
| 1730 | ***                               | 21.7 0.1  |
| 1740 | ***                               | 15.4 0.0  |
| 1750 | ***STOP                           |           |

ANONYMOUS LAKE EXAMPLE

EXAMPLE FOR INPUT/OUTPUT USING PORT

UNITS ARE IN FEET

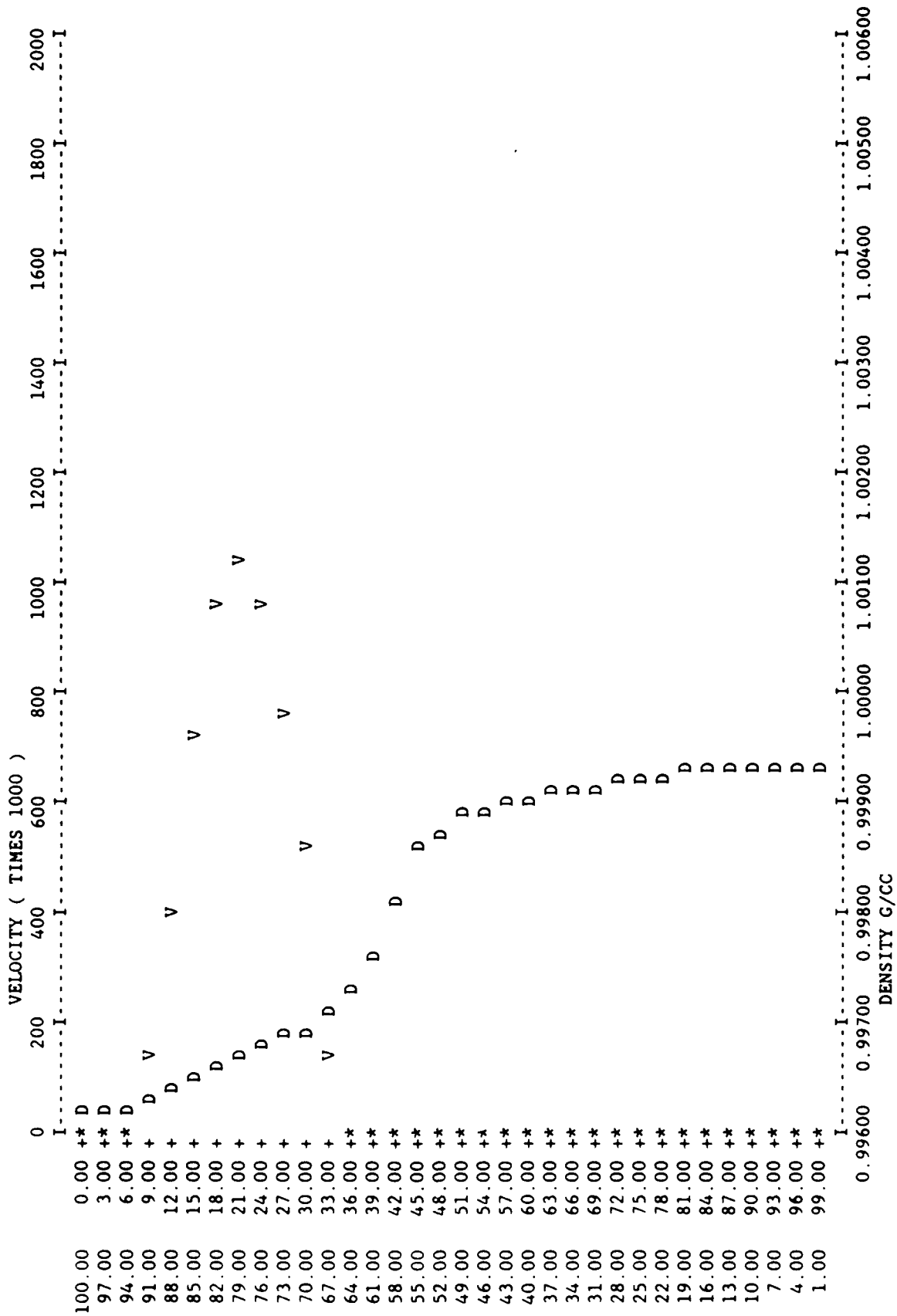
PORT ELEVATION 80.000  
PORT VERTICAL DIMENSION 5.000  
DISCHARGE, VOLUME FLOW PER SEC. 100.0000  
WITHDRAWAL ANGLE, RAD 3.1400

TOTAL DISCHARGE, VOLUME PER SEC 100.0000

LOWER WITHDRAWAL LIMIT ( ACTUAL ) HEIGHT ABOVE BOTTOM  
LOWER WITHDRAWAL LIMIT ( THEORETICAL ) HEIGHT ABOVE BOTTOM  
UPPER WITHDRAWAL LIMIT ( ACTUAL ) HEIGHT ABOVE BOTTOM  
UPPER WITHDRAWAL LIMIT ( THEORETICAL ) HEIGHT ABOVE BOTTOM  
OUTFLOW DENSITY 0.99655 G/CC  
OUTFLOW TEMPERATURE 26.96

65.781  
65.781  
94.531  
94.531  
ELEVATION  
ELEVATION  
ELEVATION  
ELEVATION

| ELEVATION | DEPTH | DENSITY | NORM. VEL. | FLOW    | TEMPERATURE |
|-----------|-------|---------|------------|---------|-------------|
| 99.500    | 0.50  | 0.99600 | 0.0000     | 0.0000  | 28.90       |
| 97.500    | 2.50  | 0.99601 | 0.0000     | 0.0000  | 28.89       |
| 94.500    | 5.50  | 0.99609 | 0.0000     | 0.0000  | 28.61       |
| 91.500    | 8.50  | 0.99617 | 0.1022     | 1.9055  | 28.34       |
| 88.500    | 11.50 | 0.99626 | 0.3755     | 7.0034  | 28.02       |
| 85.500    | 14.50 | 0.99636 | 0.6951     | 12.9650 | 27.66       |
| 82.500    | 17.50 | 0.99646 | 0.9260     | 17.2724 | 27.30       |
| 79.500    | 20.50 | 0.99656 | 1.0000     | 18.6533 | 26.95       |
| 76.500    | 23.50 | 0.99664 | 0.9259     | 17.2719 | 26.66       |
| 73.500    | 26.50 | 0.99672 | 0.7398     | 13.7991 | 26.36       |
| 70.500    | 29.50 | 0.99680 | 0.4823     | 8.9959  | 26.07       |
| 67.500    | 32.50 | 0.99695 | 0.1144     | 2.1336  | 25.47       |
| 64.500    | 35.50 | 0.99715 | 0.0000     | 0.0000  | 24.71       |
| 61.500    | 38.50 | 0.99743 | 0.0000     | 0.0000  | 23.57       |
| 58.500    | 41.50 | 0.99799 | 0.0000     | 0.0000  | 21.13       |
| 55.500    | 44.50 | 0.99841 | 0.0000     | 0.0000  | 19.15       |
| 52.500    | 47.50 | 0.99860 | 0.0000     | 0.0000  | 18.14       |
| 49.500    | 50.50 | 0.99872 | 0.0000     | 0.0000  | 17.46       |
| 46.500    | 53.50 | 0.99877 | 0.0000     | 0.0000  | 17.20       |
| 43.500    | 56.50 | 0.99882 | 0.0000     | 0.0000  | 16.93       |
| 40.500    | 59.50 | 0.99886 | 0.0000     | 0.0000  | 16.68       |
| 37.500    | 62.50 | 0.99890 | 0.0000     | 0.0000  | 16.43       |
| 34.500    | 65.50 | 0.99894 | 0.0000     | 0.0000  | 16.17       |
| 31.500    | 68.50 | 0.99898 | 0.0000     | 0.0000  | 15.92       |
| 28.500    | 71.50 | 0.99902 | 0.0000     | 0.0000  | 15.68       |
| 25.500    | 74.50 | 0.99906 | 0.0000     | 0.0000  | 15.44       |
| 22.500    | 77.50 | 0.99910 | 0.0000     | 0.0000  | 15.20       |
| 19.500    | 80.50 | 0.99913 | 0.0000     | 0.0000  | 15.00       |
| 16.500    | 83.50 | 0.99913 | 0.0000     | 0.0000  | 15.00       |
| 13.500    | 86.50 | 0.99913 | 0.0000     | 0.0000  | 15.00       |
| 10.500    | 89.50 | 0.99913 | 0.0000     | 0.0000  | 15.00       |
| 7.500     | 92.50 | 0.99913 | 0.0000     | 0.0000  | 15.00       |
| 4.500     | 95.50 | 0.99913 | 0.0000     | 0.0000  | 15.00       |
| 1.500     | 98.50 | 0.99913 | 0.0000     | 0.0000  | 15.00       |



ANONYMOUS LAKE EXAMPLE

EXAMPLE FOR INPUT/OUTPUT USING WEIR

UNITS ARE IN FEET

WEIR CREST ELEVATION 65.000

WEIR LENGHT 100.000

DISCHARGE, VOLUME FLOW PER SEC. 100.0000

TOTAL DISCHARGE, VOLUME PER SEC 100.0000

LOWER WITHDRAWAL LIMIT ( ACTUAL ) HEIGHT ABOVE BOTTOM

LOWER WITHDRAWAL LIMIT ( THEORETICAL ) HEIGHT ABOVE BOTTOM

UPPER WITHDRAWAL LIMIT ( ACTUAL ) HEIGHT ABOVE BOTTOM

UPPER WITHDRAWAL LIMIT ( THEORETICAL ) HEIGHT ABOVE BOTTOM

OUTFLOW DENSITY 0.99661 G/CC

OUTFLOW TEMPERATURE 26.74

OUTFLOW CONCENTRATION OF DISSOLVED OXYGEN

2.51

64.238

ELEVATION

64.238

ELEVATION

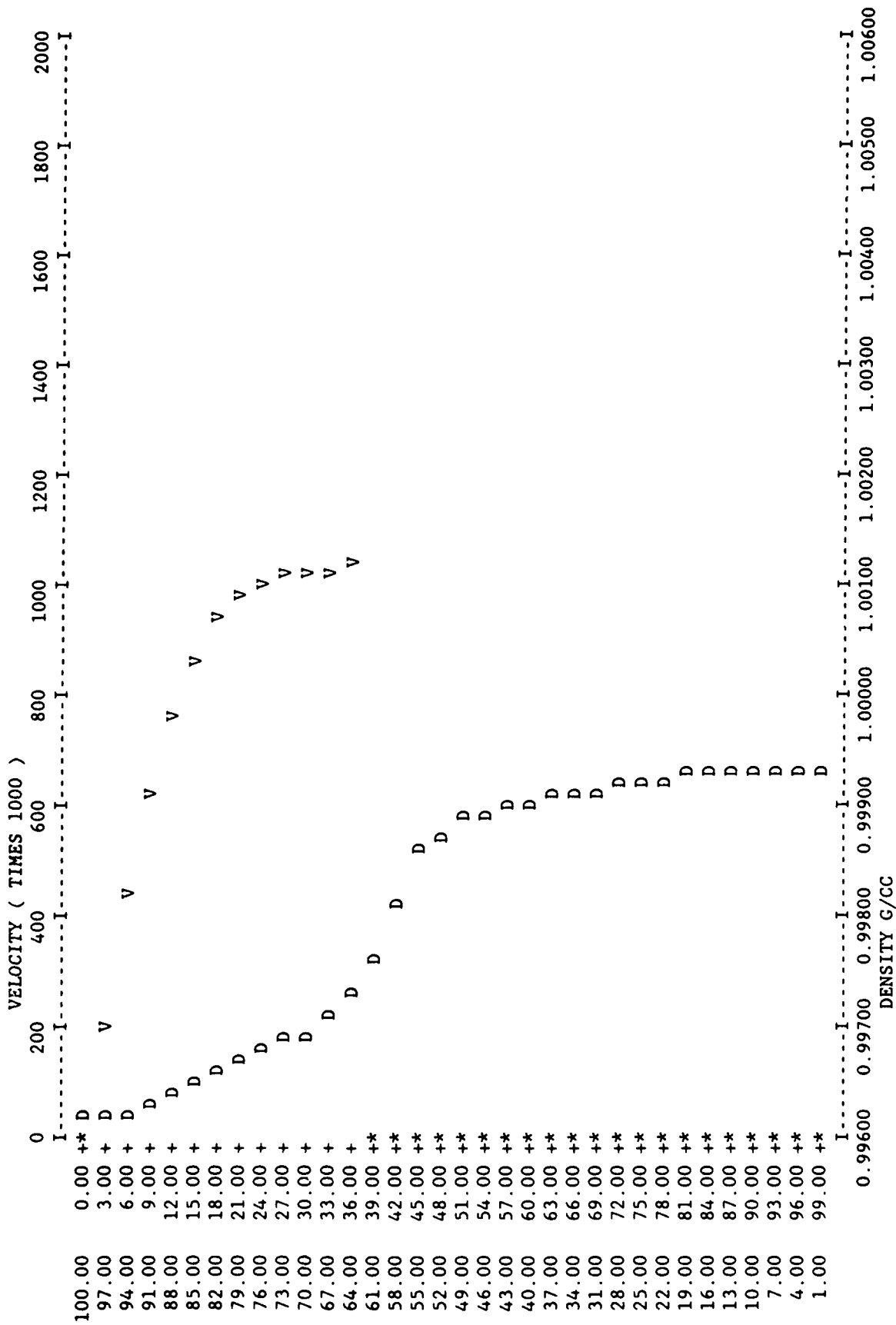
100.000

ELEVATION

100.000

Instruction Report E-87-2  
July 1992

| ELEVATION | DEPTH | DENSITY | NORM. VEL. | FLOW    | TEMPERATURE | DISSOLVED OX |
|-----------|-------|---------|------------|---------|-------------|--------------|
| 99.500    | 0.50  | 0.99600 | 0.0000     | 0.0000  | 28.90       | 3.20         |
| 97.500    | 2.50  | 0.99601 | 0.1636     | 1.7156  | 28.89       | 3.20         |
| 94.500    | 5.50  | 0.99609 | 0.4010     | 4.2055  | 28.61       | 3.20         |
| 91.500    | 8.50  | 0.99617 | 0.5837     | 6.1209  | 28.34       | 3.20         |
| 88.500    | 11.50 | 0.99626 | 0.7280     | 7.6343  | 28.02       | 3.17         |
| 85.500    | 14.50 | 0.99636 | 0.8356     | 8.7634  | 27.66       | 3.11         |
| 82.500    | 17.50 | 0.99646 | 0.9074     | 9.5159  | 27.30       | 3.06         |
| 79.500    | 20.50 | 0.99656 | 0.9520     | 9.9836  | 26.95       | 3.01         |
| 76.500    | 23.50 | 0.99664 | 0.9768     | 10.2439 | 26.66       | 2.63         |
| 73.500    | 26.50 | 0.99672 | 0.9906     | 10.3881 | 26.36       | 2.12         |
| 70.500    | 29.50 | 0.99680 | 0.9971     | 10.4571 | 26.07       | 1.88         |
| 67.500    | 32.50 | 0.99695 | 0.9998     | 10.4847 | 25.47       | 1.68         |
| 64.500    | 35.50 | 0.99715 | 1.0000     | 10.4872 | 24.71       | 1.51         |
| 61.500    | 38.50 | 0.99743 | 0.0000     | 0.0000  | 23.57       | 1.33         |
| 58.500    | 41.50 | 0.99799 | 0.0000     | 0.0000  | 21.13       | 0.53         |
| 55.500    | 44.50 | 0.99841 | 0.0000     | 0.0000  | 19.15       | 0.43         |
| 52.500    | 47.50 | 0.99860 | 0.0000     | 0.0000  | 18.14       | 0.35         |
| 49.500    | 50.50 | 0.99872 | 0.0000     | 0.0000  | 17.46       | 0.29         |
| 46.500    | 53.50 | 0.99877 | 0.0000     | 0.0000  | 17.20       | 0.26         |
| 43.500    | 56.50 | 0.99882 | 0.0000     | 0.0000  | 16.93       | 0.23         |
| 40.500    | 59.50 | 0.99886 | 0.0000     | 0.0000  | 16.68       | 0.20         |
| 37.500    | 62.50 | 0.99890 | 0.0000     | 0.0000  | 16.43       | 0.20         |
| 34.500    | 65.50 | 0.99894 | 0.0000     | 0.0000  | 16.17       | 0.20         |
| 31.500    | 68.50 | 0.99898 | 0.0000     | 0.0000  | 15.92       | 0.20         |
| 28.500    | 71.50 | 0.99902 | 0.0000     | 0.0000  | 15.68       | 0.18         |
| 25.500    | 74.50 | 0.99906 | 0.0000     | 0.0000  | 15.44       | 0.15         |
| 22.500    | 77.50 | 0.99910 | 0.0000     | 0.0000  | 15.20       | 0.11         |
| 19.500    | 80.50 | 0.99913 | 0.0000     | 0.0000  | 15.00       | 0.07         |
| 16.500    | 83.50 | 0.99913 | 0.0000     | 0.0000  | 15.00       | 0.02         |
| 13.500    | 86.50 | 0.99913 | 0.0000     | 0.0000  | 15.00       | 0.00         |
| 10.500    | 89.50 | 0.99913 | 0.0000     | 0.0000  | 15.00       | 0.00         |
| 7.500     | 92.50 | 0.99913 | 0.0000     | 0.0000  | 15.00       | 0.00         |
| 4.500     | 95.50 | 0.99913 | 0.0000     | 0.0000  | 15.00       | 0.00         |
| 1.500     | 98.50 | 0.99913 | 0.0000     | 0.0000  | 15.00       | 0.00         |



BLANK

C-10



#### APPENDIX D: ERROR CODES

1. SELECT has various internal checks that test for errors in the input file data and format, and for errors in some of the program's internal computations. When a check is failed, the program prints an appropriate error message and terminates program execution.

2. The error message contains an error number, a subroutine name, and a statement regarding the type of error. With this information, the line at which the error occurred (and the cause) can often be easily determined by the user through the use of the program code. It is suggested that the user locate the subroutine in which the error occurred and then scan the CALL ERROR () statements therein for the error number. (The error number is the first number in the ERROR argument list.) The appropriate CALL ERROR () statement should be near the line(s) of code in which the failure occurred.

NOTE: Most errors (error numbers 1010-1380 excluding 1080 and 1345) are due to input file format problems. If the user determines that the error is in the input file, check for missing lines, misplaced lines, misspelled words, etc., in the input file.

| <u>Error Number</u> | <u>Subroutine of Occurrence</u> | <u>Input Format Card</u> | <u>Explanation</u>                                                                                                                                   |
|---------------------|---------------------------------|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1010                | XREAD                           | 02                       | "DATA" was expected as first four characters of input line.                                                                                          |
| 1020                | XREAD                           | 05                       | "METR" or "ENGL" was expected as first four characters of input line.                                                                                |
| 1030                | XREAD                           | 06                       | "TABL" was expected as first four characters of input line.                                                                                          |
| 1040                | XREAD                           | 07                       | "THIC" was expected as first four characters of input line.                                                                                          |
| 1050                | XREAD                           | 08                       | "INTE" was expected as first four characters of input line.                                                                                          |
| 1060                | XREAD                           | 09                       | "SURF" was expected as first four characters of input line.                                                                                          |
| 1070                | XREAD                           | 10                       | "BOTT" was expected as first four characters of input line.                                                                                          |
| 1080                | XREAD                           | 07                       | The number of computational layers dimensioned in the model has been exceeded. Probable solution is to increase the desired thickness of each layer. |
| 1100                | XREAD                           | 11                       | "WEIR" or "PORT" was expected as first four characters of input line.                                                                                |
| 1110                | XREAD                           | 12                       | "VDIM" was expected as first four characters of input line.                                                                                          |
| 1120                | XREAD                           | 13                       | "HDIM" was expected as first four characters of input line.                                                                                          |

(Continued)

| <u>Error Number</u> | <u>Subroutine of Occurrence</u> | <u>Input Format Card</u> | <u>Explanation</u>                                                                              |
|---------------------|---------------------------------|--------------------------|-------------------------------------------------------------------------------------------------|
| 1130                | XREAD                           | 14                       | "DEPT" or "ELEV" or "HEIG" was expected as first four characters of input line.                 |
| 1140                | XREAD                           | 15                       | "FLOW" was expected as first four characters of input line.                                     |
| 1150                | XREAD                           | 16                       | "ANGL" was expected as first four characters of input line.                                     |
| 1160                | XREAD                           | 17                       | "SUBM" or "FREE" was expected as first four characters of input line.                           |
| 1170                | XREAD                           | 18                       | "COEF" was expected as first four characters of input line.                                     |
| 1180                | XREAD                           | 19                       | "LENG" was expected as first four characters of input line.                                     |
| 1200                | XREAD                           | 20                       | "DEPTH" or "ELEV" or "HEIG" was expected as first four characters of input line.                |
| 1210                | XREAD                           | 21                       | "FLOW" was expected as first four characters of input line.                                     |
| 1215                | XREAD                           | 22                       | "TAIL" was expected as first four characters of input line.                                     |
| 1220                | XREAD                           | 23                       | "NUMB" was expected as first four characters of input line.                                     |
| 1225                | XREAD                           | 24                       | "TEMP" or "DENS" was expected as first four characters of the second alphanumeric format field. |

(Continued)

| <u>Error Number</u> | <u>Subroutine of Occurrence</u> | <u>Input Format Card</u> | <u>Explanation</u>                                                                                         |
|---------------------|---------------------------------|--------------------------|------------------------------------------------------------------------------------------------------------|
| 1230                | XREAD                           | 23                       | "DEPT" or "ELEV" or "HEIG" was expected as first four characters of input line TABTYP not equal to 1       |
| 1240                | XREAD                           | 25                       | "DENS" was expected as first four characters of input line TABTYP not equal to 1                           |
| 1250                | XREAD                           | 23                       | "DEPT" or "ELEV" or "HEIG" was expected as first four characters of input line TABTYP not equal to 1       |
| 1260                | XREAD                           | 23                       | "DENS" was expected as first four characters of the second alphanumeric format field TABTYP not equal to 1 |
| 1270                | XREAD                           | 27                       | "NUMB" or "QUAL" or "STOP" was expected as first four characters of input line                             |
| 1280                | XREAD                           | 28                       | "TEMP" or "STOP" was expected as first four characters of input line                                       |
| 1290                | XREAD                           | 28                       | "FAHR" or "CENT" was expected as first four characters of the second alphanumeric format field             |
| 1300                | XREAD                           | 29                       | "DEPT" or "ELEV" or "HEIG" was expected as first four characters of input line TABTYP not equal to 1       |
| 1310                | XREAD                           | 31                       | "TEMP" was expected as first four characters of input line TABTYP not equal to 1                           |
| 1320                | XREAD                           | 29                       | "DEPT" or "ELEV" or "HEIG" was expected as first four characters of input line TABTYP equal to 1           |

(Continued)

| Error Number | Subroutine of Occurrence | Input Format Card | Explanation                                                                                            |
|--------------|--------------------------|-------------------|--------------------------------------------------------------------------------------------------------|
| 1330         | XREAD                    | 29                | "TEMP" was expected as first four characters of the second alphanumeric format field TABTYP equal to 1 |
| 1340         | XREAD                    | 33                | "QUAL" or "STOP" was expected as first four characters of input line                                   |
| 1345         | XREAD                    |                   | Dissolved oxygen must be the first quality profile listed if aeration techniques are modeled           |
| 1350         | XREAD                    | 34                | "NUMB" was expected as first four characters of input line                                             |
| 1360         | XREAD                    | 35                | "DEPT" or "ELEV" or "HEIG" was expected as first four characters of input line TABTYP not equal to 1   |
| 1370         | XREAD                    | 35                | "DEPT" or "ELEV" or "HEIG" was expected as first four characters of input line TABTYP equal to 1       |
| 1380         | XREAD                    | 39                | "STOP" was expected as first four characters of input line                                             |
| 1400         | OUTVEL                   | 15                | Flow rate entered for a port was less than or equal to zero Flow rates must be greater than zero       |
| 1410         | OUTVEL                   | 14                | Center-line height of port exceeded depth of water                                                     |
| 1420         | VPORT                    | 21                | Flow rate for weir found to be less than or equal to zero Flow rate must be greater than zero          |

Continued

| Error Number | Subroutine of Occurrence | Input Format Card | Explanation                                                                                                                                                     |
|--------------|--------------------------|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1500         | VPORT                    | --                | Convergence on the upper or lower withdrawal limit has not been reached.                                                                                        |
| 1510         | VPORT                    | --                | Same as error number 1500                                                                                                                                       |
| 1520         | VPORT                    | --                | Elevation of maximum velocity in withdrawal profile was found to be above the water surface or below the bottom                                                 |
| 1600         | VWEIR                    | --                | Internal computation check failure Function FWEIR(X) must be positive at the crest elevation and negative at the bottom to allow convergence on the lower limit |
| 1610         | VWEIR                    | --                | Convergence on the lower withdrawal limit has not been reached                                                                                                  |
| 1800         | SHIFT                    | --                | Number of iterations internally programmed for convergence on shifted limit is not sufficient                                                                   |

APPENDIX E PROGRAM LISTING

```
0001 PROGRAM SELECT
0002 *****
0003 *
0004 * P R O G R A M S E L E C T *
0005 *
0006 *****
0007 *
0008 * ***** ***** *****
0009 * * VERSION 1.3 * * VERSION 1.3 * * VERSION 1.3 *
0010 * ***** ***** *****
0011 *
0012 *
0013 * VERSION 1.0
0014 *
0015 * COMPUTES THE LIMITS OF THE ZONE OF WITHDRAWAL
0016 * AND THE DISTRIBUTION OF FLOW WITHIN THAT ZONE. THE
0017 * PROGRAM ALSO COMPUTES THE OUTFLOW DENSITY AND QUALITY FROM
0018 * INPUT DENSITY AND QUALITY PROFILES. VERSION 1.0 IS SUPPORTED
0019 * BY THE WES EWQOS INSTRUCTION REPORT #E-87-2 "SELECT: A
0020 * NUMERICAL MODEL FOR SELECTIVE WITHDRAWAL" BY
0021 * JACK E. DAVIS ET AL.
0022 *
0023 *
0024 * VERSION 1.1 FEBRUARY 18, 1988
0025 *
0026 * THE INPUT AND OUTPUT FILE CODES WERE HARDWIRED IN PROGRAM
0027 * THE INPUT FILE IS 05 AND MUST BE CALLED SELECT IN AND THE
0028 * OUTPUT FILE IS 06 AND MUST BE CALLED SELECT OUT
0029 *
0030 *
0031 * VERSION 1.2 JULY 20, 1990
0032 *
0033 * CORRECTED AN ERROR IN ROUTINE DENINT. THE ROUTINE CAN NO
0034 * LONGER SEARCH FOR DENSITIES OUTSIDE THE POOL WHEN A WEIR
0035 * IS BEING MODELED
0036 *
0037 *
0038 * VERSION 1.3 JANUARY 6, 1992
0039 *
0040 * MADE SUPERFICIAL CHANGES TO THE CODE APPEARANCE TO IMPROVE
0041 * READABILITY. ALSO MADE INCONSEQUENTIAL CHANGES TO THE OUTPUT
0042 * ROUTINE TO MAKE OUTPUT FILE MORE PC PRINTER COMPATIBLE. THE
0043 * SUBROUTINES WERE REORDERED TO APPEAR ALPHABETICALLY. FUNCTION
0044 * NAMES IN VPORT WERE CHANGED TO MATCH THE VARIABLE NAMES IN THE
0045 * DOCUMENTATION
0046 *
0047 * AN ERROR IN CONVERTING FAHRENHEIT TO CENTIGRADE WAS CORRECTED
0048 * DENINT WAS CORRECTED TO ACCOMMODATE POINT SINES AT THE
0049 * RESERVOIR BOTTOM. THE SMITH ET AL. FORMULATION WAS
```

Instruction Report E-87-2  
July 1992

MAIN

```

0050 * CORRECTED TO COMPUTE THE DENSITY GRADIENT FROM THE PORT
0051 * CENTER LINE TO THE FREE LIMIT, RATHER THAN FROM THE BOUNDARY
0052 * OF INTERFERENCE. FOR ONE BOUNDARY OF INTERFERENCE, THE
0053 * BOHAN AND GRACE CALCULATION OF THE THEORETICAL LIMIT NOW
0054 * CORRECTLY USES A FRACTION MULTIPLIER FOR THE AMOUNT OF FLOW
0055 * IN THE TRUNCATED WITHDRAWAL ZONE. THE PORT ORDERING
0056 * ROUTINE IN XREAD WAS CORRECTED TO INCLUDE FLOW AND ANGLE.
0057 * (HOWINGTON)
0058 *
0059 COMMON / AA / QMETR, NSETS, G, HEADING (18), TITLE (18)
0060 COMMON / BB / IFILE, KFILE
0061 COMMON / CC / DELZ, INTER, SURFACE, BOTTOM
0062 COMMON / DD / WTHETA (5), WANGLE
0063 COMMON / EE / NPORTS, QPORT, QWEIR, QPLOT, QPWEIR
0064 COMMON / FF / PVDIM (5), PHGT (5), FLOW (5), PHDIM (5)
0065 COMMON / GG / COEF, QSUB, QQUAL
0066 COMMON / HH / WRLNG, WRHGT, WRFLOW
0067 COMMON / II / NUMD, DEN (100), YD (100), QDEN, DENPRT
0068 COMMON / JJ / NUMT, QCENT, TEMP (100), YT (100), QTEMP
0069 COMMON / KK / NQUAL, NUMQ (4), NAMEQ (5,4),
0070 & QUAL (4,100), YQ (4,100)
0071 COMMON / LL / ISURF, HGT(100), DEPTH, Y (100)
0072 COMMON / MM / SUMOUT, VEL(100), FLORAT
0073 COMMON / NN / HCTPRT, VDIM, QTLIM, QBLIM, QSINK1,
0074 & QSINK2, QSHIFT
0075 COMMON / OO / LENGTH, CREST, HDIM
0076 COMMON / PP / LOWLIM, TOPLIM, HGTLOW, HGTTOP, V (100), VM
0077 COMMON / QQ / VS (100, 6), NOUTS
0078 COMMON / RR / ZUP (6), ZDN (6), LTOP (6), LLOW (6)
0079 COMMON / SS / WTHDRW (100), DENOUT, TEMOUT, QALOUT (4)
0080 COMMON / TT / QVENT, QAERA, QTWFUN, TWEL
0081 *
0082 LOGICAL QDEN, QCENT
0083 LOGICAL QVENT, QAERA
0084 *
0085 DATA C1, C2 / -3.9863, 508929.2 /
0086 DATA C3, C4 / 288.9414, 68.12963 /
0087 *
0088 * DENSITIES FROM TEMPERATURES
0089 *
0090 DENFUN (X) = 1. - (X + C1) ** 2 / C2
0091 & * (X + C3) / (X + C4)
0092 *
0093 * FAHRENHEIT TO CENTIGRADE
0094 *
0095 TEMFUN (T) = (5. / 9.) * (T - 32.)
0096 *
0097 * READ CONTROL INFORMATION
0098 *
0099 IFILE = 5

```

MAIN

```
0100 KFILE = 6
0101 *
0102 OPEN (5, FILE = 'SELECT.IN' , STATUS = 'OLD')
0103 OPEN (6, FILE = 'SELECT.OUT' , STATUS = 'NEW')
0104 *
0105 CALL XREAD
0106 *
0107 *.... INITIATE LOOP FOR THE NUMBER OF DATA SETS
0108 *
0109 DO 130 I = 1, NSETS
0110 *
0111 *.... READ INPUT DATA AND CONSTRUCT COMPLETE DATA TABLES
0112 *
0113 CALL XREAD
0114 *
0115 *.... DEVELOP DENSITY PROFILE IF NOT GIVEN
0116 *
0117 IF (QDEN) GO TO 110
0118 DO 100 J = 1, ISURF
0119 IF (.NOT. QCENT) TEMP(J) = TEMFUN (TEMP(J))
0120 DEN (J) = DENFUN (TEMP(J))
0121 100 CONTINUE
0122 110 CONTINUE
0123 *
0124 *.... CHECK FOR STABLE DENSITY PROFILE
0125 *
0126 DO 120 K = 2, ISURF
0127 IF (DEN (K - 1) .GE. DEN (K)) GO TO 120
0128 WRITE (KFILE , 500)
0129 STOP
0130 120 CONTINUE
0131 *
0132 *.... COMPUTE SELECTIVE WITHDRAWAL LIMITS AND VELOCITIES AND
0133 * RESULTANT OUTFLOW DENSITY AND QUALITIES
0134 *
0135 CALL OUTVEL
0136 *
0137 *.... MODIFY OUTFLOW D.O. IF GATED STRUCTURE
0138 * AERATION IS USED.
0139 *
0140 IF (QAERA) CALL AERATE
0141 *
0142 *.... MODIFY OUTFLOW D.O. IF TURBINE VENTING IS USED
0143 *
0144 IF (QVENT) CALL VENTING
0145 *
0146 *.... PRINT RESULTS
0147 *
0148 CALL XPRINT
0149 130 CONTINUE
```

Instruction Report E-87-2  
July 1992

MAIN

```
0150 STOP
0151 500 FORMAT (/// 10X, 27HDENSITY PROFILE UNSTABLE - ,
0152 & 16HPROGRAM STOPPED)
0153 END
```

AERATE

```

0001 SUBROUTINE AERATE
0002 *****
0003 *
0004 * S U B R O U T I N E A E R A T E *
0005 *
0006 *****
0007 *
0008 *.... PREDICTS THE RELEASE D.O. (MG/L) THROUGH GATED CONDUIT OULET
0009 * WORKS USING THE ENERGY DISSIPATION MODEL OUTLINED IN
0010 * TR-E-81-5 BY WILHELMS AND SMITH
0011 *
0012 COMMON / AA / QMETR, NSETS, G, HEADING(18), TITLE(18)
0013 COMMON / CC / DELZ, INTER, SURFACE, BOTTOM
0014 COMMON / LL / ISURF, HGT(100), DEPTH, Y(100)
0015 COMMON / MM / SUMOUT, VEL(100), FLORAT
0016 COMMON / SS / WTHDRW(100), DENOUT, TEMOUT, QALOUT(4)
0017 COMMON / TT / QVENT, QAERA, QTWFUN, TWEL
0018 *
0019 LOGICAL QVENT, QAERA, QTWFUN
0020 LOGICAL QMETR
0021 *
0022 *.... FUNCTIONS FOR CALCULATIONS ADJUSTED ESCAPE COEFFICIENT
0023 *
0024 CT(X) = C20 * 1.022 ** (X - 20.0)
0025 *
0026 *.... DISSOLVED OXYGEN SATURATION
0027 *
0028 DOSAT(X) = 1 / (0.00209 * X + 0.06719)
0029 *
0030 *.... ALTITUDE CORRECTION FACTOR
0031 *
0032 BARO(X) = 1.0 - 3.224 E-5 * X
0033 C20 = 0.045
0034 IF (QMETR) C20 = 0.1476
0035 *
0036 *.... ADJUST ESCAPE COEFFICIENT
0037 *
0038 C = CT(TEMOUT)
0039 *
0040 *.... OXYGEN SATURATION CONCENTRATION ADJUSTED FOR ALTITUDE
0041 *
0042 ALT = BOTTOM
0043 IF (QMETR) ALT = BOTTOM * 3.28
0044 CSAT = DOSAT(TEMOUT) * BARO(ALT)
0045 *
0046 *.... DELTA-H THROUGH STRUCTURE
0047 *
0048 DELH = DEPTH + BOTTOM - TWEL
0049 *
0050 *.... DISSOLVED OXYGEN DEFICIT ENTERING STRUCTURE

```

Instruction Report E-87-2  
July 1992

AERATE

```
0051 *
0052 DI = CSAT - QALOUT(1)
0053 *
0054 *.... REAERATE DISCHARGE
0055 *
0056 DF = DI * EXP(- C * DELH)
0057 *
0058 *.... RELEASE DISSOLVED OXYGEN
0059 *
0060 QALOUT(1) = CSAT - DF
0061 RETURN
0062 END
```

DENINT

```

0001 REAL FUNCTION DENINT (X)
0002 *****
0003 *
0004 * R E A L F U N C T I O N D E N I N T *
0005 *
0006 *****
0007 *
0008 *.... DETERMINE DENSITY AT ANY LOCATION
0009 *
0010 COMMON / CC / DELZ, INTER, SURFACE, BOTTOM
0011 COMMON / EE / NPORTS, QPORT, QWEIR, QPLOT, QPWEIR
0012 COMMON / II / NUMD, DEN(100), YD(100), QDEN, DENPRT
0013 COMMON / LL / ISURF, HGT(100), DEPTH, Y(100)
0014 COMMON / NN / HGTPRT, VDIM, QTLIM, QBLIM,
0015 & QSINK1, QSINK2, QSHIFT
0016 *
0017 INTEGER SIGN
0018 *
0019 LOGICAL QDEN, QTLIM, QBLIM, QSINK1, QSINK2, QSHIFT, QWEIR
0020 *
0021 DATA SMALL / 1.E - 05 /
0022 *
0023 LAYER = 1. + X / DELZ
0024 *
0025 *.... IF WEIRS ARE BEING MODELED, CODE ONLY SEARCHES IN THE POOL
0026 * FOR DENSITIES. IF PORTS ARE BEING MODELED THE CODE SEARCHES
0027 * BOTH IN AND OUTSIDE THE POOL FOR DENSITIES
0028 *
0029 IF (QWEIR) THEN
0030 IF (LAYER .LE. 1) THEN
0031 LAYER = 1
0032 DENINT = DEN (LAYER)
0033 RETURN
0034 ELSE IF (LAYER .GT. ISURF) THEN
0035 LAYER = ISURF
0036 DENINT = DEN (LAYER)
0037 RETURN
0038 END IF
0039 END IF
0040 *
0041 IF (X .GE. DEPTH .OR. X .LT. 0.0) GO TO 120
0042 *
0043 *.... IF THE LAYER IS OUTSIDE THE POOL, THE DENSITY IS
0044 * EXTRAPOLATED BASED ON A LINEAR DENSITY GRADIENT EXTENDED
0045 * FROM THE PORT CENTERLINE TO THE DESIRED BOUNDARY LAYER
0046 *
0047 *.... FIND THE DENSITY INSIDE THE POOL
0048 *
0049 ELMID = DELZ * (FLOAT (LAYER) - 0.5)
0050 DIFF = ABS (ELMID - X)

```

Instruction Report E-87-2  
July 1992

DENINT

```

0051 IF (DIFF .LT. SMALL) THEN
0052 DENINT = DEN (LAYER)
0053 RETURN
0054 ENDIF
0055 *
0056 IF (LAYER .EQ. ISURF .AND. X .GE. ELMID) THEN
0057 SLOPE = (DEN (ISURF - 1) - DEN (ISURF))
0058 & / DELZ
0059 DENINT = DEN (LAYER) - DIFF * SLOPE
0060 RETURN
0061 ELSEIF (LAYER .EQ. 1 .AND. X .LE. ELMID) THEN
0062 SLOPE = (DEN (1) - DEN (2)) / DELZ
0063 DENINT = DEN (LAYER) + DIFF * SLOPE
0064 RETURN
0065 ENDIF
0066 *
0067 SIGN = (ELMID - X) / ABS (ELMID - X)
0068 IJK = - (SIGN - 1) / 2
0069 IJ = LAYER + IJK
0070 JK = IJ - 1
0071 SLOPE = (DEN (IJ) - DEN (JK)) / DELZ
0072 ELTOP = DELZ * (FLOAT (IJ) - 0.5)
0073 DENINT = DEN (IJ) - (ELTOP - X) * SLOPE
0074 RETURN
0075 120 CONTINUE
0076 *
0077 *.... FIND THE DENSITY OUTSIDE THE POOL
0078 *
0079 IF (HGTPRT .GE. DEPTH - 0.5 * DELZ) THEN
0080 DGRDT = (DEN (ISURF) - DEN (ISURF - 1))
0081 & / DELZ
0082 ELSE
0083 DGRDT = (DEN (ISURF) - DENPRT) / (DEPTH - HGTPRT)
0084 ENDIF
0085 *
0086 IF (HGTPRT .LE. 0.5 * DELZ) THEN
0087 DGRDB = (DEN (1) - DEN (2)) / DELZ
0088 ELSE
0089 DGRDB = (DEN (1) - DENPRT) / HGTPRT
0090 ENDIF
0091 IF (LAYER .GE. ISURF) DGRD = DGRDT
0092 IF (LAYER .LE. 1) DGRD = DGRDB
0093 DENINT = DGRD * ABS (HGTPRT - X) + DENPRT
0094 RETURN
0095 END

```

DVPLOT

```

0001 SUBROUTINE DVPLOT
0002 *****
0003 *
0004 * S U B R O U T I N E D V P L O T *
0005 *
0006 *****
0007 *
0008 *.... THIS SUBROUTINE PLOTS PROFILES OF DENSITY AND VELOCITY
0009 * VERSUS DEPTH
0010 *
0011 COMMON / BB / IFILE, KFILE
0012 COMMON / CC / DELZ, INTER, SURFACE, BOTTOM
0013 COMMON / II / NUMD, DEN (100), YD (100), QDEN, DENPRT
0014 COMMON / LL / ISURF, HGT (100), DEPTH, Y (100)
0015 COMMON / MM / SUMOUT, VEL (100), FLORAT
0016 *
0017 CHARACTER*1 T, BLANK, PEGGED, FIRSTD, BOTH, COL1(100),
0018 * V, D, LASTV, LASTD, COL2(100), FIRSTV
0019 *
0020 DIMENSION VSPACE(11), DSPACE(11)
0021 *
0022 CHARACTER*2 PLUS
0023 INTEGER VSPACE
0024 LOGICAL QRANGE, QDEN
0025 *
0026 DATA PEGGED, BLANK, V, D, PLUS / '*', ' ', 'V', 'D', ' +'/
0027 DATA VELMAX / 2.0 /
0028 DATA BOTH / 'B' /
0029 *
0030 WRITE (KFILE, 500)
0031 *
0032 *.... DETERMINE MAXIMUM VELOCITY
0033 *
0034 VMAX = VEL (1)
0035 DO 100 I = 2, ISURF
0036 IF (VEL (I) .GT. VMAX) VMAX = VEL (I)
0037 100 CONTINUE
0038 *
0039 *.... DETERMINE VELOCITY AXIS SPACING
0040 *
0041 CHANGE = VELMAX * 100.
0042 VSPACE (1) = 0
0043 DO 110 K = 1, 10
0044 VSPACE(K + 1) = VSPACE (K) + INT (CHANGE)
0045 110 CONTINUE
0046 *
0047 *.... DETERMINE MAXIMUM AND MINIMUM DENSITIES FOR AXIS SPACING
0048 *
0049 DMIN = DEN (1)
0050 DMAX = DEN (1)

```

Instruction Report E-87-2  
July 1992

DV PLOT

```

0051 DO 115 I = 2, ISURF
0052 DMIN = AMIN1 (DMIN, DEN (I))
0053 DMAX = AMAX1 (DMAX, DEN (I))
0054 115 CONTINUE
0055 DUM = DMIN * 1000.
0056 DMIN = FLOAT (INT (DUM)) / 1000.
0057 DDIF = DMAX - DMIN
0058 DMAX = DMIN + 0.01
0059 IF (DDIF .GT. 0.01) DMAX = DMIN + 0.02
0060 *
0061 *.... DETERMINE DENSITY AXIS SPACING
0062 *
0063 DENDIF = DMAX - DMIN
0064 CHANGE2 = DENDIF / 10.
0065 DSPACE (1) = DMIN
0066 DO 120 J = 1, 10
0067 DSPACE (J + 1) = DSPACE (J) + CHANGE2
0068 120 CONTINUE
0069 *
0070 *.... PRINT VELOCITY AXIS AND LABEL
0071 *
0072 WRITE (KFILE, 510)
0073 WRITE (KFILE, 520) (VSPACE (K), K = 1, 11)
0074 WRITE (KFILE, 530)
0075 *
0076 *.... BEGIN TO FILL IN COLUMN ARRAY
0077 *
0078 ELEV = BOTTOM + DEPTH + DELZ
0079 DEEP = - DELZ
0080 DO 170 I = 1, ISURF
0081 K = ISURF - I + 1
0082 DEEP = DEEP + DELZ
0083 ELEV = ELEV - DELZ
0084 *
0085 *.... BLANK OUT VELOCITY COLUMN ARRAY
0086 *
0087 FIRSTV = BLANK
0088 LASTV = BLANK
0089 DO 130 L = 1, 100
0090 COL1 (L) = BLANK
0091 130 CONTINUE
0092 *
0093 *.... DETERMINE IF VELOCITY VALUES ARE WITHIN RANGE OF PLOT
0094 *
0095 VL = VEL (K)
0096 IF (VL .LE. 0.) FIRSTV = PEGGED
0097 IF (VL .GT. VELMAX) LASTV = PEGGED
0098 *
0099 *.... DETERMINE COLUMN FOR PLOTTING EACH VELOCITY COMPONENT
0100 *

```

DV PLOT

```

0101 QRANGE = VL .GT. 0. .AND. VL .LE. VELMAX
0102 IRANGE = 0
0103 IF (QRANGE) IRANGE = 1
0104 IF (.NOT. QRANGE) GO TO 140
0105 IJK = INT ((VL / VELMAX) * 100.)
0106 IJK = IJK + 1
0107 COL1 (IJK) = V
0108 140 CONTINUE
0109 *
0110 *.... BLANK OUT DENSITY COLUMN ARRAY
0111 *
0112 FIRSTD = BLANK
0113 LASTD = BLANK
0114 DO 150 L = 1, 100
0115 COL2 (L) = BLANK
0116 150 CONTINUE
0117 *
0118 *.... DETERMINE IF DENSITY VALUES ARE WITHIN RANGE OF PLOT
0119 *
0120 DN = DEN(K)
0121 IF (DN .LE. 0.) FIRSTD = PEGGED
0122 IF (DN .GT. DMAX) LASTD = PEGGED
0123 *
0124 *.... DETERMINE COLUMN FOR PLOTTING EACH DENSITY COMPONENT
0125 *
0126 QRANGE = DN .GT. 0. .AND. DN .LE. DMAX
0127 IRANGE = 0
0128 IF (QRANGE) IRANGE = 1
0129 IF (.NOT. QRANGE) GO TO 160
0130 IJK = INT (100. * (DN - DMIN) / DENDIF)
0131 IJK = IJK + 1
0132 COL2 (IJK) = D
0133 160 CONTINUE
0134 DO 165 L = 1, 100
0135 IF (COL1 (L) .EQ. V) GO TO 162
0136 COL1 (L) = COL2 (L)
0137 GO TO 165
0138 162 CONTINUE
0139 IF (COL2 (L) .NE. D) GO TO 165
0140 COL1 (L) = BOTH
0141 165 CONTINUE
0142 *
0143 *.... PRINT ONE LINE OF PLOT
0144 *
0145 WRITE (KFILE, 550) ELEV , DEEP , PLUS , FIRSTV ,
0146 & FIRSTD, COL1 , LASTV , LASTD
0147 170 CONTINUE
0148 *
0149 *.... PRINT BOTTOM AXIS
0150 *

```

Instruction Report E-87-2  
July 1992

DV PLOT

```
0151 WRITE (KFILE , 530)
0152 WRITE (KFILE , 570) (DSPACE (J) , J = 1 , 11)
0153 WRITE (KFILE , 540)
0154 *
0155 *..... QUIT
0156 *
0157 RETURN
0158 *
0159 500 FORMAT (1H1 , ///)
0160 510 FORMAT (30X , 23HVELOCITY (TIMES 1000))
0161 520 FORMAT (11X , 11I10)
0162 530 FORMAT (20X , 10 (10HI-----) , 1H1)
0163 540 FORMAT (30X , 12HDENSITY G/CC)
0164 550 FORMAT (1X , F7.2 , 1X , F7.2 , A2 , 104A1)
0165 570 FORMAT (11X , 11F10.5)
0166 END
```

ERROR

```

0001 SUBROUTINE ERROR (ERR, SUBR, CHK, XCHK1, XCHK2, XCHK3)
0002 *****
0003 *
0004 * S U B R O U T I N E E R R O R
0005 *
0006 *****
0007 *
0008 *.... THERE ARE TWO TYPES OF ERROR CHECKS - ONE FOR INPUT
0009 * FORMATTING AND ONE FOR PROGRAM COMPUTATIONS. FOR PROGRAM
0010 * COMPUTATIONS, ONLY THE ERROR NUMBER AND THE SUBROUTINE-OF-
0011 * OCCURRANCE NAME ARE PASSED TO THE ERROR SUBROUTINE. THEN AN
0012 * APPROPRIATE STATEMENT IS MATCHED WITH THE ERROR NUMBER AND
0013 * PRINTED. THE OTHER ARGUMENTS PASSED ARE EQUAL TO ZERO
0014 *
0015 *.... FOR FORMAT ERRORS, THE ERROR NUMBER, THE SUBROUTINE-OF-
0016 * OCCURRANCE NAME, THE STRING IN ERROR, AND THE STRING(S)
0017 * EXPECTED BY THE PROGRAM ARE PASSED. UNUSED ARGUMENTS ARE
0018 * PASSED AS ZERO
0019 *
0020 COMMON / BB / IFILE, KFILE
0021 *
0022 INTEGER ERR
0023 *
0024 CHARACTER*4 CHK, XCHK1, XCHK2, XCHK3
0025 CHARACTER*6 SUBR
0026 *
0027 *.... PRINT ERROR NUMBER AND SUBROUTINE-OF-OCCURRANCE
0028 *
0029 WRITE (KFILE, 500) ERR, SUBR
0030 *
0031 *.... MATCH ERROR CODE WITH PROPER OUTPUT STATEMENT
0032 *
0033 *.... ERROR CODES FOR IMPROPER INPUT VALUES
0034 *
0035 IF (ERR .EQ. 1400) WRITE (KFILE, 510)
0036 IF (ERR .EQ. 1410) WRITE (KFILE, 520)
0037 IF (ERR .EQ. 1420) WRITE (KFILE, 530)
0038 *
0039 *.... ERROR CODES FOR INTERNAL COMPUTATIONS
0040 *
0041 IF (ERR .EQ. 2100 .OR. ERR .EQ. 2070 .OR.
0042 & ERR .EQ. 2090 .OR. ERR .EQ. 2300)
0043 & WRITE (KFILE, 540)
0044 IF (ERR .EQ. 2310) WRITE (KFILE, 570)
0045 IF (ERR .EQ. 2320) WRITE (KFILE, 580)
0046 *
0047 *.... ERROR CODES FOR HALF INTERVAL SEARCH CONVERGENCE ERRORS
0048 *
0049 IF (ERR .EQ. 2310) WRITE (KFILE, 570)
0050 IF (ERR .EQ. 2080 .OR. ERR .EQ. 2110)

```

ERROR

```

0051 & WRITE (KFILE, 590)
0052 IF (ERR .EQ. 1080) WRITE (KFILE, 600)
0053 *
0054 *.... IF THIS SUBROUTINE USED ONE OF THE ABOVE 'IF' STATEMENTS
0055 * THEN THE FOLLOWING IF STATEMENT IS USED TO EXIT PROGRAM
0056 *
0057 IF (XCHK1 .EQ. '0 ' .AND. XCHK2 .EQ. '0 '
0058 & .AND. XCHK3 .EQ. '0 ') GO TO 100
0059 *
0060 *.... ERROR CODES FOR INPUT FORMAT FAILURE CHECKS
0061 *
0062 *.... IF VARIABLE 'CHECK' WAS TESTED FOR ONLY ONE STRING VALUE
0063 * DURING PROGRAM OPERATION
0064 *
0065 IF (XCHK2 .EQ. '0 ' .AND. XCHK3 .EQ. '0 ')
0066 & WRITE (KFILE, 610) CHK, XCHK1
0067 *
0068 *.... IF VARIABLE 'CHECK' WAS TESTED FOR ONE OF TWO STRING VALUES
0069 * DURING PROGRAM OPERATION
0070 *
0071 IF (XCHK2 .NE. '0 ' .AND. XCHK3 .EQ. '0 ')
0072 & WRITE (KFILE, 620) CHK, XCHK1, XCHK2
0073 *
0074 *.... IF VARIABLE 'CHECK' WAS TESTED FOR ONE OF THREE STRING VALUES
0075 * DURING PROGRAM OPERATION
0076 *
0077 IF (XCHK2 .NE. '0 ' .AND. XCHK3 .NE. '0 ')
0078 & WRITE (KFILE, 630) CHK, XCHK1, XCHK2, XCHK3
0079 100 STOP
0080 *
0081 500 FORMAT (/, 'ERROR NUMBER ', I4,
0082 & ' OCCURRED IN SUBROUTINE' , A6)
0083 510 FORMAT (/, 'FLOW RATE FOR A PORT WAS FOUND TO BE', /,
0084 & 'LESS THAN OR EQUAL TO ZERO.', /, 'ENTERED FLOWRATE',
0085 & ' MUST BE GREATER THAN ZERO.')
0086 520 FORMAT (/, 'CENTER LINE OF PORT WAS HIGHER ', /,
0087 & 'THAN THE WATER SURFACE.')
0088 530 FORMAT (/, 'FLOW RATE FOR WEIR MUST BE > THAN ZERO')
0089 540 FORMAT (/, '*** COMPUTATIONAL ERROR IN PROGRAM ')
0090 570 FORMAT (/, 'CONVERGENCE IN SUBROUTINE SHIFT FAILED.')
0091 580 FORMAT (/, 'IN HALF INTERVAL SEARCH, CONVERGENCE ON THE',
0092 & /, 'UPPER OR LOWER WITHDRAWAL LIMIT FAILED')
0093 590 FORMAT (/, 'IN HALF INTERVAL SEARCH, CONVERGENCE ON ', /,
0094 & 'THE UPPER OR LOWER WITHDRAWAL LIMIT FAILED.')
0095 600 FORMAT (/, 'NUMBER OF LAYERS DIMENSIONED WAS EXCEEDED')
0096 610 FORMAT (/, 'INTERNAL CHECK WAS "', A4, '"', /,
0097 & 'PROGRAM EXPECTED "', A4, '" AS FIRST FOUR', /,
0098 & 'CHARACTERS OF INPUT LINE.')
0099
0100

```

ERROR

```
0101 620 FORMAT (/, 'INTERNAL CHECK WAS ', A4, ' ', /,
0102 6 'PROGRAM EXPECTED ', A4, ' ' OR ' ', A4, ' ', /,
0103 6 'AS FIRST FOUR CHARACTERS OF INPUT LINE ')
0104 630 FORMAT (/, 'INTERNAL CHECK WAS ', A4, ' ', /,
0105 6 'PROGRAM EXPECTED ', A4, ' ' OR ' ', A4, ' ', /,
0106 6 'OR ', A4, ' ' AS FIRST FOUR CHARACTERS OF',
0107 6 ' INPUT LINE ')
0108 END
```

Instruction Report E-87-2  
July 1992

INTERP

```

0001 SUBROUTINE INTERP (PQUAL, YV, NUMV)
0002 *****
0003 *
0004 * S U B R O U T I N E I N T E R P *
0005 *
0006 *****
0007 *
0008 *..... PROGRAM TO DEVELOP COMPLETE DATA TABLES OR PROFILES BY LINEAR
0009 * INTERPOLATION OF INPUT DATA
0010 *
0011 * COMMON / CC / DELZ, INTER, SURFACE, BOTTOM
0012 * COMMON / LL / ISURF, HGT (100), DEPTH, Y (100)
0013 *
0014 * DIMENSION PQUAL (100), YV (100), PVALUE (100),
0015 * & DM (100), PM (100)
0016 *
0017 * INTEGER SIGN1, SIGN2
0018 *
0019 *..... TOLERANCE, 0.01% OF LAYER THICKNESS
0020 *
0021 * SMALL = 0.0001 * DELZ
0022 *
0023 *..... IF DATA IS ORDERED FROM TOP TO BOTTOM, IT MUST BE RESEQUENCED
0024 * FROM BOTTOM TO TOP
0025 *
0026 * IF (YV(1) .LT. YV(2)) GO TO 120
0027 * NV = NUMV + 1
0028 *
0029 *..... RESEQUENCE
0030 *
0031 * DO 100 I = 1, NUMV
0032 * DM(I) = YV(NV - I)
0033 * PM(I) = PQUAL(NV - I)
0034 * 100 CONTINUE
0035 * DO 110 I = 1, NUMV
0036 * YV(I) = DM(I)
0037 * PQUAL(I) = PM(I)
0038 * 110 CONTINUE
0039 * 120 CONTINUE
0040 *
0041 *..... ASSIGN PARAMETER VALUE TO INTERP VARIABLE
0042 *
0043 * DO 130 I = 1, NUMV
0044 * PVALUE(I) = PQUAL(I)
0045 * 130 CONTINUE
0046 *
0047 *..... START PROFILE DEVELOPMENT
0048 *
0049 *..... ANY CENTER LINE ELEVATION BELOW LOWEST PARAMETER POINT
0050 * IS ASSIGNED THE VALUE OF THAT PARAMETER POINT

```

INTERP

```
0051 *
0052 DO 140 I = 1, ISURF
0053 IF (Y(I) .GT. YV(1)) GO TO 150
0054 PQUAL(I) = PVALUE(1)
0055 140 CONTINUE
0056 150 CONTINUE
0057 J = I
0058 *
0059 *.... ANY CENTER LINE ELEV. ABOVE HIGHEST PARAMETER POINT IS
0060 * ASSIGNED THAT PARAMETER VALUE
0061 *
0062 DO 160 I = 1, ISURF
0063 L = ISURF + 1 - I
0064 IF (Y(L) .LT. YV(NUMV)) GO TO 170
0065 PQUAL(L) = PVALUE(NUMV)
0066 160 CONTINUE
0067 170 CONTINUE
0068 *
0069 *.... FIRST CENTER LINE BELOW HIGHEST PARAMETER POINT
0070 *
0071 K = L
0072 *
0073 *.... FIRST CENTER LINE ABOVE LOWEST PARAMETER POINT
0074 *
0075 I = J - 1
0076 180 CONTINUE
0077 I = I + 1
0078 IF (I .GT. K) GO TO 270
0079 NMINUS = NUMV - 1
0080 *
0081 *.... LOCATE DATA POINTS ABOVE AND BELOW THE LAYER CENTER LINE
0082 *
0083 DO 230 M = 1, NMINUS
0084 DIFF1 = ABS (YV(M) - Y(I))
0085 IF (DIFF1 .LT. SMALL) GO TO 190
0086 *
0087 *.... IF SIGN1 IS NEGATIVE, FIRST DATA POINT LIES BELOW CENTER
0088 * LINE IF SIGN1 IS POSITIVE, POINT LIES ABOVE CENTER LINE
0089 *
0090 SIGN1 = (YV(M) - Y(I)) / DIFF1 * 1.2
0091 GO TO 200
0092 190 CONTINUE
0093 SIGN1 = 0
0094 200 CONTINUE
0095 DIFF2 = ABS (YV(M+1) - Y(I))
0096 IF (DIFF2 .LT. SMALL) GO TO 210
0097 *
0098 *.... IF SIGN2 IS NEGATIVE, SECOND DATA POINT LIES BELOW CENTER
0099 * LINE IF SIGN2 IS POSITIVE, POINT IS ABOVE CENTER LINE
0100 *
```

Instruction Report E-87-2  
July 1992

INTERP

```

0101 SIGN2 = (YV (M + 1) - Y (I)) / DIFF2 * 1.2
0102 GO TO 220
0103 210 CONTINUE
0104 SIGN2 = 0
0105 220 CONTINUE
0106 *
0107 *.... IF BOTH DATA POINTS ARE BELOW CENTER LINE, LOOP AGAIN
0108 *
0109 IF (SIGN1 .EQ. SIGN2 .AND. SIGN1 .EQ. -1) GO TO 230
0110 GO TO 240
0111 230 CONTINUE
0112 240 CONTINUE
0113 *
0114 *.... DOES CENTER LINE LIE VERY CLOSE TO DATA POINT
0115 *
0116 IF (SIGN1 .EQ. 0) GO TO 250
0117 IF (SIGN2 .EQ. 0) GO TO 260
0118 *
0119 *.... INTERPOLATE BETWEEN DATA POINTS FOR VALUE AT CENTER LINE
0120 *
0121 PQUAL(I) = ((PVALUE (M + 1) - PVALUE (M))
0122 & * (Y (I) - YV (M)) /
0123 & (YV (M + 1) - YV (M))) + PVALUE (M)
0124 GO TO 180
0125 250 CONTINUE
0126 *
0127 *.... ASSIGN LOWER DATA POINT VALUE TO CENTER LINE
0128 *
0129 PQUAL (I) = PVALUE (M)
0130 GO TO 180
0131 260 CONTINUE
0132 *
0133 *.... ASSIGN UPPER DATA POINT VALUE TO CENTER LINE
0134 *
0135 PQUAL (I) = PVALUE (M + 1)
0136 GO TO 180
0137 270 CONTINUE
0138 RETURN
0139 END

```

OUTVEL

```

0001 SUBROUTINE OUTVEL
0002 *****
0003 *
0004 * S U B R O U T I N E O U T V E L *
0005 *
0006 *****
0007 *
0008 *.... THIS IS THE CONTROL MODULE FOR THE COMPUTATION PORTION OF
0009 * THIS PROGAM
0010 *
0011 COMMON / DD / WTHETA (5), WANGLE
0012 COMMON / EE / NPORTS, QPORT, QWEIR, QPLOT, QPWEIR
0013 COMMON / FF / PVDIM (5), PHGT (5), FLOW (5), PHDIM (5)
0014 COMMON / GG / COEF, QSUB, QQUAL
0015 COMMON / HH / WRLNG, WRHGT, WRFLOW
0016 COMMON / II / NUMD, DEN (100), YD (100), QDEN, DENPRT
0017 COMMON / JJ / NUMT, QCENT, TEMP(100), YT (100), QTEMP
0018 COMMON / KK / NQUAL, NUMQ (4), NAMEQ (5,4),
0019 & QUAL (4,100), YQ (4,100)
0020 COMMON / LL / ISURF, HGT (100), DEPTH, Y (100)
0021 COMMON / MM / SUMOUT, VEL (100), FLORAT
0022 COMMON / NN / HGTPRT, VDIM, QTLIM, QBLIM, QSINK1,
0023 & QSINK2, QSHIFT
0024 COMMON / OO / LENGTH, CREST, HDIM
0025 COMMON / PP / LOWLIM, TOPLIM, HGTLOW, HGTTOP, V (100), VM
0026 COMMON / QQ / VS (100,6), NOUTS
0027 COMMON / RR / ZUP (6), ZDN (6), LTOP (6), LLOW (6)
0028 COMMON / SS / WTHDRW (100), DENOUT, TEMOUT, QALOUT (4)
0029 COMMON / TT / QVENT, QAERA, QTWFUN, TWEL
0030 *
0031 INTEGER TOPLIM
0032 *
0033 LOGICAL QPORT, QWEIR, QSUB, QTEMP, QPWEIR
0034 *
0035 REAL LENGTH
0036 *
0037 CHARACTER*4 XDUMY, XDUMY1, XDUMY2, XDUMY3, NAMEQ
0038 CHARACTER*6 SUBR
0039 *
0040 DATA XDUMY, XDUMY1, XDUMY2, XDUMY3 / 4 * '0' /
0041 DATA SUBR / 'OUTVEL' /
0042 *
0043 LAYER (X) = 1. + X / DELZ
0044 NOUTS = NPORTS
0045 IF (QWEIR) NOUTS = NOUTS + 1
0046 *
0047 *.... INITIALIZE THE TOTAL OUTFLOW FLOW RATE PROFILE
0048 *
0049 DO 100 I = 1, ISURF
0050 VEL (I) = 0.0

```

Instruction Report E-87-2  
July 1992

OUTVEL

```

0051 100 CONTINUE
0052 SUMOUT = 0.0
0053 *
0054 *.... DETERMINE TYPE OF WITHDRAWAL
0055 *
0056 IF (QPORT) GO TO 110
0057 IF (QWEIR) GO TO 140
0058 *
0059 *.... SELECTIVE WITHDRAWAL FOR ORIFICE FLOW
0060 *
0061 110 CONTINUE
0062 DO 130 K = 1, NPORTS
0063 *
0064 *.... VARIABLE ASSIGNMENTS
0065 *
0066 QPWEIR = .FALSE.
0067 FLORAT= FLOW(K)
0068 IF (FLORAT .LE. 0.)
0069 & CALL ERROR (1400 , SUBR, XDUMY, XDUMY1, XDUMY2,
0070 & XDUMY3)
0071 SUMOUT = SUMOUT + FLORAT
0072 VDIM = PVDIM(K)
0073 HDIM = PHDIM(K)
0074 HGTPRT = PHGT(K)
0075 IF (HGTPRT .GE. DEPTH)
0076 & CALL ERROR (1410 , SUBR, XDUMY, XDUMY1, XDUMY2,
0077 & XDUMY3)
0078 DENPRT = DENINT (HGTPRT)
0079 WANGLE = WTHETA (K)
0080 *
0081 *.... CHECK FOR PARTIALLY SUBMERGED PORT
0082 *
0083 FLODEP = DEPTH - HGTPRT + VDIM/2.
0084 IF (VDIM .LE. FLODEP) GO TO 115
0085 VW = FLORAT / (FLODEP * HDIM)
0086 VHL = (VW * FLODEP ** .5) / HDIM
0087 IF (VHL .GT. 0.5) GO TO 115
0088 *
0089 *.... PARTIALLY SUBMERGED PORT - TREAT AS A WEIR
0090 *
0091 QPWEIR = .TRUE.
0092 QSUB = .TRUE.
0093 LENGTH = HDIM
0094 CREST = HGTPRT - VDIM/2.
0095 *
0096 CALL VWEIR
0097 *
0098 GO TO 116
0099 115 CONTINUE
0100 *

```

OUTVEL

```

0101 *.... FULLY SUBMERGED PORT
0102 *
0103 CALL VPORT
0104 *
0105 116 CONTINUE
0106 *
0107 *.... ASSIGN FLOW RATE PROFILE VALUES CALCULATED IN VPORT
0108 * OR VWEIR TO AN ARRAY
0109 *
0110 DO 120 I = 1, ISURF
0111 VS(I,K) = V(I)
0112 120 CONTINUE
0113 *
0114 *.... ASSIGN WITHDRAWAL LIMIT VALUES TO AN ARRAY
0115 *
0116 ZUP (K) = HGTTOP
0117 ZDN (K) = HGTLOW
0118 LTOP (K) = TOPLIM
0119 LLOW (K) = LOWLIM
0120 130 CONTINUE
0121 140 CONTINUE
0122 IF (.NOT. QWEIR) GO TO 160
0123 *
0124 *.... SELECTIVE WITHDRAWAL FOR WEIR FLOW
0125 *
0126 FLORAT = WRFLOW
0127 SUMOUT = SUMOUT + FLORAT
0128 IF (FLORAT .LE. 0.)
0129 & CALL ERROR (1420 , SUBR, XDUMY, XDUMY1, XDUMY2,
0130 & XDUMY3)
0131 LENGTH = WRLNG
0132 CREST = WRHGT
0133 *
0134 *.... DETERMINE WITHDRAWAL LIMITS AND FLOW RATE PROFILES
0135 *
0136 CALL VWEIR
0137 *
0138 *.... ASSIGN FLOW RATE PROFILE VALUES CALCULATED IN VWEIR TO AN
0139 * ARRAY
0140 *
0141 DO 150 I = 1, ISURF
0142 VS(I,NOUTS) = V(I)
0143 150 CONTINUE
0144 *
0145 *.... ASSIGN WITHDRAWAL LIMIT VALUES TO ARRAY
0146 *
0147 ZUP (NOUTS) = HGTTOP
0148 ZDN (NOUTS) = HGTLOW
0149 LTOP (NOUTS) = TOPLIM
0150 LLOW (NOUTS) = LOWLIM

```

Instruction Report E-87-2  
July 1992

OUTVEL

```

0151 160 CONTINUE
0152 *
0153 *.... IF MUTIPLE OUTLETS CALL SHIFT
0154 *
0155 IF (NOUTS .GT. 1) CALL SHIFT
0156 *
0157 *.... DETERMINE TOTAL OUTFLOW FLOW RATE DISTRIBUTION
0158 *
0159 DO 180 I = 1, ISURF
0160 DO 170 J = 1, NOUTS
0161 VEL (I) = VEL (I) + VS (I , J)
0162 170 CONTINUE
0163 180 CONTINUE
0164 *
0165 *.... FIND MAXIMUM LAYER FLOW RATE
0166 *
0167 VMAX = VEL (LOWLIM)
0168 DO 185 I = 1, ISURF
0169 VMAX = AMAX1 (VMAX, VEL (I))
0170 185 CONTINUE
0171 *
0172 *.... ASSIGN LAYER FLOW RATES TO WTHDRW(I)
0173 *
0174 DO 190 I = 1, ISURF
0175 WTHDRW (I) = VEL (I) * HGT (I)
0176 190 CONTINUE
0177 DO 200 I = 1, ISURF
0178 VEL (I) = VEL (I) / VMAX
0179 200 CONTINUE
0180 *
0181 *.... COMPUTE THE RELEASE DENSITY
0182 *
0183 SUMDF = 0.
0184 DO 210 I = 1, ISURF
0185 SUMDF = SUMDF + DEN (I) * WTHDRW (I)
0186 210 CONTINUE
0187 DENOUT = SUMDF / SUMOUT
0188 *
0189 *.... COMPUTE RELEASE TEMPERATURE
0190 *
0191 IF (.NOT. QTEMP) GO TO 230
0192 SUMTF = 0.
0193 DO 220 I = 1, ISURF
0194 SUMTF = SUMTF + TEMP (I) * WTHDRW (I)
0195 220 CONTINUE
0196 TEMOUT = SUMTF / SUMOUT
0197 230 CONTINUE
0198 *
0199 *.... COMPUTE RELEASE QUALITIES
0200 *

```

OUTVEL

```
0201 IF (NQUAL .EQ. 0) GO TO 260
0202 DO 250 J = 1, NQUAL
0203 SUMQF = 0.
0204 DO 240 I = 1, ISURF
0205 SUMQF = SUMQF + QUAL(J,I) * WTHDRW (I)
0206 240 CONTINUE
0207 QALOUT (J) = SUMQF / SUMOUT
0208 250 CONTINUE
0209 260 CONTINUE
0210 RETURN
0211 END
```

Instruction Report E-87-2  
July 1992

SHIFT

```

0001 SUBROUTINE SHIFT
0002 *****
0003 *
0004 * S U B R O U T I N E S H I F T
0005 *
0006 *****
0007 *
0008 *.... THIS SUBROUTINE SHIFTS THE INNER WITHDRAWAL LIMITS WHEN TWO
0009 * WITHDRAWAL ZONES OVERLAP
0010 *
0011 COMMON / AA / QMETR, NSETS, G, HEADING(18), TITLE(18)
0012 COMMON / BB / IFILE, KFILE
0013 COMMON / CC / DELZ, INTER, SURFACE, BOTTOM
0014 COMMON / EE / NPORTS, QPORT, QWEIR, QPLOT, QPWEIR
0015 COMMON / FF / PVDIM (5), PHGT (5), FLOW (5), PHDIM (5)
0016 COMMON / II / NUMD, DEN (100), YD (100), QDEN, DENPRT
0017 COMMON / HH / WRLNG, WRHGT, WRFLOW
0018 COMMON / LL / ISURF, HGT (100), DEPTH, Y (100)
0019 COMMON / MM / SUMOUT, VEL(100), FLORAT
0020 COMMON / NN / HGTprt, VDIM , QTLIM, QBLIM, QSINK1,
0021 & QSINK2, QSHIFT
0022 COMMON / OO / LENGTH, CREST, HDIM
0023 COMMON / PP / LOWLIM, TOPLIM, HGTLOW, HGTTOP, V (100), VM
0024 COMMON / QQ / VS (100,6), NOUTS
0025 COMMON / RR / ZUP (6), ZDN (6), LTOP (6), LLOW (6)
0026 *
0027 LOGICAL QPORT , QWEIR , QSBLIM, QSTLIM, QBLIM,
0028 & Q1 , Q2 ; QTLIM
0029 LOGICAL QPRINT, QSINK1, QSINK2, QSHIFT
0030 *
0031 INTEGER TOPLIM, XXX
0032 *
0033 CHARACTER*4 XDUMY, XDUMY1, XDUMY2, XDUMY3
0034 CHARACTER*6 SUBR
0035 *
0036 DATA MAX / 10 /
0037 DATA TINY / 1.E-07 /
0038 DATA QPRINT / .TRUE. /
0039 DATA XDUMY, XDUMY1, XDUMY2, XDUMY3 / 4*'0 ' /
0040 DATA SUBR / 'SHIFT' /
0041 *
0042 *.... LAYER NO. LOCATION OF X
0043 *
0044 LAYER (X) = 1. + X / DELZ
0045 FROUD (X, D, ZL) = SQRT (G * ABS (1. -
0046 & DENINT (X) / D) * ABS (X - ZL))
0047 *
0048 *.... BASED ON BOHAN AND GRACE
0049 *
0050 FSHIFT (VH, X, D, ZL) = VH - HTEST * FROUD (X, D, ZL)

```

SHIFT

```

0051 *
0052 *.... TOLERANCE, 10% OF THE LAYER THICKNESS
0053 *
0054 SMALL = .10 * DELZ
0055 *
0056 *.... INITIALIZE LOGICAL VARIABLE
0057 *
0058 QSTLIM = .FALSE.
0059 QSBLIM = .FALSE.
0060 QBLIM = .FALSE.
0061 QTLIM = .FALSE.
0062 QSHIFT = .FALSE.
0063 *
0064 *.... CHECK FOR OVERLAP OF WITHDRAWAL ZONES. IS LOWER LIMIT OF
0065 * UPPER PORT BELOW UPPER LIMIT OF LOWER PORT
0066 *
0067 NMINUS = NOUTS - 1
0068 DO 260 K = 1, NMINUS
0069 H = ZDN (K + 1) - ZUP (K)
0070 IF (H .GE. 0.) GO TO 260
0071 *
0072 *.... SET UP PARAMETERS FOR SHIFTING LIMITS
0073 *
0074 H = ABS (H)
0075 IF (QWEIR .AND. K .EQ. NOUTS - 1) GO TO 100
0076 HO = PHGT (K + 1) - PHGT (K)
0077 GO TO 110
0078 100 CONTINUE
0079 *
0080 *.... ZONES FROM WEIR AND A PORT OVERLAP
0081 *
0082 HO = CREST - PHGT(K)
0083 110 CONTINUE
0084 HTEST = .7 * (H / HO) ** 1.25
0085 VH1 = 0.
0086 VH2 = 0.
0087 *
0088 *.... K + 1 IS THE UPPER PORT, K IS THE LOWER PORT
0089 *
0090 L1 = LLOW (K + 1)
0091 L2 = LTOP (K)
0092 *
0093 *.... NUMBER OF LAYERS BETWEEN OVERLAPPING LIMITS, INCLUSIVE ...
0094 *
0095 LAY = L2 - L1 + 1
0096 DO 120 I = L1, L2
0097 *
0098 *.... DETERMINE AVERAGE VELOCITY IN OVERLAPPING REGION
0099 *
0100 VH1 = VH1 + VS (I , K)

```

Instruction Report E-87-2  
July 1992

SHIFT

```

0101 VH2 = VH2 + VS (I , K + 1)
0102 120 CONTINUE
0103 VH1 = VH1 / LAY
0104 VH2 = VH2 / LAY
0105 *
0106 *.... CALCULATE DENSITIES AT LIMITS
0107 *
0108 DENS2 = DENINT (ZUP (K))
0109 DENS1 = DENINT (ZDN (K + 1))
0110 *
0111 *.... LIMIT VARIABLES REASSIGNED
0112 *
0113 ZL2 = ZUP (K)
0114 ZL1 = ZDN (K + 1)
0115 *
0116 *.... CHECK FOR INTERFERENCE FROM SURFACE OR BOTTOM
0117 *
0118 QSTLIM = FSHIFT (VH1, DEPTH, DENS2, ZL2) .GE. 0.
0119 QSBLIM = FSHIFT (VH2, 0., DENS1, ZL1) .GE. 0.
0120 IF (.NOT. QSTLIM) GO TO 125
0121 *
0122 *.... SOLVE FOR THE SHIFTED LIMIT
0123 *
0124 *.... CHECK FIRST FOR DENSITY DIFFERENCE
0125 * BETWEEN THE PORT AND THE SURFACE
0126 *
0127 IF (ABS (DEN (ISURF) - DENINT (PHGT (K))) .GT.
0128 & TINY) GO TO 125
0129 ZUP (K) = DEPTH
0130 GO TO 175
0131 125 CONTINUE
0132 *
0133 *.... DETERMINE FUNCTION SIGN AT EACH SEARCH LIMIT AND ORIGINAL
0134 * UPPER LIMIT OF LOWER PROFILE IF THE FUNCTION SIGN IS
0135 * POSITIVE , ASSUMED AMOUNT OF SHIFT IS LESS THAN ACTUAL
0136 * AMOUNT OF SHIFT; IF FUNCTION SIGN IS NEGATIVE, ASSUMED AMOUNT
0137 * OF SHIFT IS GREATER THAN ACTUAL AMOUNT OF SHIFT
0138 *
0139 KOUNT = 0
0140 X1 = DEPTH
0141 130 CONTINUE
0142 KOUNT = KOUNT + 1
0143 IF (KOUNT .GE. 5) GO TO 135
0144 X2 = ZUP (K)
0145 F2 = FSHIFT (VH1, X2, DENS2, ZL2)
0146 Q2 = F2 .GT. 0.
0147 X1 = X1 * 2.0
0148 F1 = FSHIFT (VH1, X1, DENS2, ZL2)
0149 Q1 = F1 .GE. 0.
0150 X3 = -2. * SMALL

```

SHIFT

```
0151 *
0152 *.... FUNCTION SIGN MUST BE POSITIVE AT THE ORIGINAL LIMIT AND
0153 * NEGATIVE AT THE NEW LIMIT, ELSE CHOOSE NEW LIMIT, X1,
0154 * 2 TIMES GREATER
0155 *
0156 IF (Q1 .OR. .NOT. Q2) GO TO 130
0157 ASSIGN 170 TO XXX
0158 GO TO 140
0159 135 CONTINUE
0160 *
0161 *.... IF THEORETICAL SHIFTED UPPER LIMIT IS NOT FOUND, IT IS
0162 * ASSIGNED TO 2 * DEPTH AND NOTED IN THE OUTPUT
0163 *
0164 IF (QPRINT) WRITE (KFILE, 500)
0165 QPRINT= .FALSE.
0166 WRITE (KFILE, 505) K
0167 WRITE (KFILE, 510)
0168 X3 = 2 * DEPTH
0169 GO TO 170
0170 140 CONTINUE
0171 *
0172 *.... INITIATE ITERATION PROCESS
0173 *
0174 DO 160 I = 1, MAX
0175 *
0176 *.... ESTABLISH A THIRD POINT BETWEEN TWO EXISTING POINTS
0177 *
0178 X4 = X3
0179 X3 = (X1 + X2) / 2.
0180 *
0181 *.... CALCULATE FUNCTION SIGN AT NEW ELEVATION
0182 *
0183 F3 = FSHIFT (VH1, X3, DENS2, ZL2)
0184 *
0185 *.... IF NEW POINT IS THE SAME AS THE PREVIOUS POINT, THEN SEARCH
0186 * IS COMPLETE
0187 *
0188 IF (ABS (X4 - X3) .LT. SMALL) GO TO XXX, (170, 200)
0189 *
0190 *.... USE AS NEW SEARCH LIMITS THE MOST RECENTLY COMPUTED POINT
0191 * AND THE REMAINING POINT OF OPPOSITE SIGN
0192 *
0193 IF (F1 * F3 .GT. 0.) GO TO 150
0194 X2 = X3
0195 F2 = F3
0196 GO TO 160
0197 150 CONTINUE
0198 X1 = X3
0199 F1 = F3
0200 160 CONTINUE
```

Instruction Report E-87-2  
July 1992

SHIFT

```

0201 *
0202 *.... CONVERGENCE HAS NOT BEEN REACHED
0203 *
0204 CALL ERROR (1800, SUBR, XDUMY, XDUMY1, XDUMY2, XDUMY3)
0205 170 CONTINUE
0206 *
0207 *.... SET UP SHIFTED UPPER LIMIT OF LOWER PROFILE
0208 *
0209 ZUP (K) = X3
0210 175 CONTINUE
0211 IF (.NOT. QSBLIM) GO TO 180
0212 *
0213 *.... CHECK DENSITY STRUCTURE FOR LOWER LIMIT OF UPPER PORT
0214 *
0215 IF (ABS (DEN (1) - DENINT (PHGT (K + 1)))
0216 & .GT. TINY) GO TO 180
0217 ZDN(K + 1) = 0.
0218 GO TO 210
0219 180 CONTINUE
0220 *
0221 *.... DETERMINE FUNCTION SIGN AT SEARCH LIMITS (1) BOTTOM
0222 * (2) ORIGINAL LOWER LIMIT OF UPPER PROFILE
0223 *
0224 X1 = - DEPTH / 2.
0225 KOUNT = 0
0226 185 CONTINUE
0227 KOUNT = KOUNT + 1
0228 IF (KOUNT .GE. 5) GO TO 190
0229 X1 = X1 * 2.0
0230 F1 = FSHIFT (VH2, X1, DENS1, ZL1)
0231 Q1 = F1 .GE. 0.
0232 X2 = ZDN(K + 1)
0233 F2 = FSHIFT (VH2, X2, DENS1, ZL1)
0234 Q2 = F2 .GT. 0.
0235 *
0236 *.... FUNCTION VALUE MUST BE NEGATIVE AT BOTTOM AND POSITIVE AT
0237 * ORIGINAL LIMIT
0238 *
0239 IF (Q1 .OR. .NOT. Q2) GO TO 185
0240 *
0241 *.... IF LIMIT IS IN POOL, USE PRIOR SEARCH PROCEDURE
0242 *
0243 ASSIGN 200 TO XXX
0244 GO TO 140
0245 190 CONTINUE
0246 *
0247 *.... IF LIMIT IS OUTSIDE THE POOL, ASSIGN IT TO DEPTH
0248 *
0249 WRITE (KFILE, 520)
0250 X3 = - DEPTH

```

SHIFT

```

0251 200 CONTINUE
0252 *
0253 *.... SET SHIFTED LOWER LIMIT OF UPPER PROFILE
0254 *
0255 ZDN (K + 1) = X3
0256 210 CONTINUE
0257 *
0258 *.... COMPUTE NEW NORMALIZED VELOCITIES AND LAYER FLOW RATES FOR
0259 * LOWER HALF OF PROFILE
0260 *
0261 *.... ASSIGN LIMITS TO VARIABLES
0262 *
0263 HGTLOW = ZDN (K)
0264 LOWLIM = LAYER (HGTLOW)
0265 HGTTOP = ZUP (K)
0266 TOPLIM = LAYER (HGTTOP)
0267 HGTPRT = PHGT (K)
0268 FLORAT = FLOW (K)
0269 QBLIM = ZDN (K) .LE. 0.
0270 IF (QSTLIM) QTLIM = .TRUE.
0271 *
0272 *.... CALL VPORT TO RECALCULATE VELOCITIES
0273 *
0274 QSHIFT = .TRUE.
0275 CALL VPORT
0276 *
0277 QSHIFT = .FALSE.
0278 DO 220 I = 1, ISURF
0279 VS (I , K) = V (I)
0280 220 CONTINUE
0281 *
0282 *.... COMPUTE NEW NORMALIZED VELOCITIES AND LAYER FLOW RATES FOR
0283 * THE UPPER HALF OF THE PROFILE
0284 *
0285 *.... ASSIGN LIMITS TO VARIABLES
0286 *
0287 HGTLOW = ZDN (K + 1)
0288 LOWLIM = LAYER (HGTLOW)
0289 HGTTOP = ZUP (K + 1)
0290 TOPLIM = LAYER (HGTTOP)
0291 IF (QWEIR .AND. K .EQ. NOUTS - 1) GO TO 230
0292 HGTPRT = PHGT (K + 1)
0293 FLORAT = FLOW (K + 1)
0294 QTLIM = ZUP (K + 1) .GE. DEPTH
0295 IF (QSBLIM) QBLIM = .TRUE.
0296 QSHIFT = .TRUE.
0297 *
0298 *.... CALL VPORT TO RECALCULATE VELOCITIES
0299 *
0300 CALL VPORT

```

Instruction Report E-87-2  
July 1992

SHIFT

```
0301 *
0302 QSHIFT = .FALSE.
0303 GO TO 240
0304 230 CONTINUE
0305 *
0306 *.... ASSIGN WEIR INFO TO VARIABLES
0307 *
0308 CREST = WRHGT
0309 LENGTH = WRLNG
0310 FLORAT = WRFLOW
0311 QTLIM = .TRUE.
0312 IF (QSBLIM) QBLIM = .TRUE.
0313 QSHIFT = .TRUE.
0314 *
0315 *.... CALL VWEIR TO CALCULATE VELOCITIES
0316 *
0317 *.... CALL VWEIR
0318 *
0319 QSHIFT = .FALSE.
0320 240 CONTINUE
0321 DO 250 I = 1, ISURF
0322 VS (I , K + 1) = V (I)
0323 250 CONTINUE
0324 260 CONTINUE
0325 500 FORMAT (1H1)
0326 510 FORMAT (// , 5X, 29H*** THEORITICAL SHIFTED UPPER,
0327 & 43H LIMIT NOT FOUND. ASSIGNED TO 2 * DEPTH ***)
0328 520 FORMAT (// , 5X, 29H*** THEORETICAL SHIFTED LOWER,
0329 & 41H LIMIT NOT FOUND. ASSIGNED TO - DEPTH ***)
0330 505 FORMAT (// , 5X, 35H*** LOWER PORT FOR THIS CASE IS NO.,
0331 & 15, 5H ***)
0332 RETURN
0333 END
```

VENTING

```

0001 SUBROUTINE VENTING
0002 *****
0003 *
0004 * S U B R O U T I N E V E N T I N G *
0005 *
0006 *****
0007 *
0008 *.... PREDICTS RESEASE D.O. BASED ON A MAXIMUM 30% REDUCTION
0009 * IN D.O. DEFICIT
0010 *
0011 COMMON / CC / DELZ, INTER, SURFACE, BOTTOM
0012 COMMON / SS / WTHDRW (100), DENOUT, TEMOUT, QALOUT (4)
0013 COMMON / TT / QVENT, QAERA, QTWFUN, TWEL
0014 *
0015 LOGICAL QVENT, QAERA, QTWFUN
0016 *
0017 *.... D.O. SATURATION
0018 *
0019 DOSAT (X) = 1 / (0.00209 * X + 0.06719)
0020 *
0021 *.... ALTITUDE CORRECTION FACTOR
0022 *
0023 BARO(X) = 1.0 - 3.224 E-5 * X
0024 *
0025 *.... OXYGEN SATURATION CONCENTRATION ADJUSTED FOR ALTITUDE
0026 *
0027 ALT = BOTTOM
0028 CSAT = DOSAT (TEMOUT) * BARO (ALT)
0029 *
0030 *.... DEFICIT CALCULATIONS; DI = INITIAL DEFICIT,
0031 * DF = FINAL DEFICIT
0032 *
0033 DI = CSAT - QALOUT (1)
0034 DF = 0.70 * DI
0035 QALOUT (1) = CSAT - DF
0036 RETURN
0037 END

```

# Instruction Report E-87-2

July 1992

## VPORT

```

0001 SUBROUTINE VPORT
0002 *****
0003 *
0004 * S U B R O U T I N E V P O R T
0005 *
0006 *****
0007 *
0008 *.... CALCULATE WITHDRAWAL LIMITS AND VELOCITY PROFILE FOR
0009 * AN ORIFICE
0010 *
0011 COMMON / AA / QMETR, NSETS, G, HEADING (18), TITLE (18)
0012 COMMON / CC / DELZ, INTER, SURFACE, BOTTOM
0013 COMMON / DD / WTHETA (5), WANGLE
0014 COMMON / II / NUMD, DEN (100), YD (100), QDEN, DENPRT
0015 COMMON / LL / ISURF, HGT (100), DEPTH, Y (100)
0016 COMMON / MM / SUMOUT, VEL (100), FLORAT
0017 COMMON / NN / HGTPRT, VDIM, QTLIM, QBLIM, QSINK1,
0018 & QSINK2, QSHIFT
0019 COMMON / OO / LENGTH, CREST, HDIM
0020 COMMON / PP / LOWLIM, TOPLIM, HGTLOW, HGTTOP, V (100), VM
0021 *
0022 LOGICAL QBLIM, QTLIM, QMETR, QSINK1, QSINK2, QSHIFT
0023 *
0024 INTEGER XXX , TOPLIM
0025 *
0026 CHARACTER*4 XDUMY, XDUMY1, XDUMY2, XDUMY3
0027 CHARACTER*6 SUBR
0028 *
0029 DATA MAX, VMAX, TINY / 10, 1., 1.0E-08 /
0030 DATA XDUMY, XDUMY1, XDUMY2, XDUMY3 / 4 * '0 ' /
0031 DATA SUBR / 'VPORT' /
0032 *
0033 *.... FUNCTION STATEMENTS TO SOLVE FOR ORIFICE WITHDRAWAL LIMITS
0034 * FOR INTERMEDIATE FLOW CONDITIONS
0035 *
0036 LAYER (X) = 1. + X / DELZ
0037 ZEE (X) = ABS (HGTPRT - X)
0038 FROUD (X) = SQRT (G * ABS (1. - DENINT (X)
0039 & / DENPRT))
0040 *
0041 *.... COMPUTE THE DIFFERENCE BETWEEN THE FLOW 'ENERGY' AND THE
0042 * ENERGY EXPENDED BASED ON BOHAN AND GRACE (1969), MODIFIED
0043 * TO INCLUDE WITHDRAWAL ANGLE CONCEPTS
0044 *
0045 QBNG (X) = FLORAT / PHIFRAC - C2 * FROUD (X)
0046 & * ZEE (X) ** 2.5
0047 *
0048 *.... FUNCTION STATEMENTS TO SOLVE FOR THE UNBOUNDED WITHDRAWAL
0049 * LIMIT WHEN THERE IS BOTTOM OR SURFACE INTERFERENCE
0050 *

```

VPORT

```

0051 DPRIME (X) = ABS (BONLIM - X)
0052 BDRATIO (X) = SMALLB / DPRIME (X) /
0053 & (1 - SMALLB / DPRIME (X))
0054 FROUDE (X) = SQRT (G * ABS (1. - DENINT (X)
0055 & / DENPRT) / ZEE (X))
0056 CHI (X) = 1. / 2. * (1. + BDRATIO (X))
0057 PHI (X) = 1. / 2. * (1 + 1 / PI
0058 & * SIN (BDRATIO (X) * PI) +
0059 & BDRATIO (X))
0060 *
0061 *.... COMPUTE THE DIFFERENCE BETWEEN THE FLOW 'ENERGY' AND THE
0062 * 'ENERGY' EXPENDED BASED ON SMITH, ET AL (1985), EQN 36
0063 *
0064 QSMITH (X) = FLORAT - C2 * FROUDE (X) * PHI (X)
0065 & / (2.0 * CHI (X)) ** 3
0066 & * DPRIME (X) ** 3
0067 *
0068 *.... TOLERANCE, 10% OF LAYER THICKNESS
0069 *
0070 SMALL = .10 * DELZ
0071 *
0072 *.... INITIALIZE LOGICAL VARIABLES
0073 *
0074 QSINK1 = .TRUE.
0075 QSINK2 = .TRUE.
0076 QSHIFT = .FALSE.
0077 *
0078 *.... SET THE VALUE OF THE ANGLE OF WITHDRAWAL COEFFICIENT
0079 * FOR THE BOUNDARY INTERFERENCE EQUATION
0080 *
0081 *.... CHECK TO SEE IF ENTERING FROM SUBROUTINE SHIFT
0082 *
0083 IF (QSHIFT) GO TO 185
0084 PI = 3.14159
0085 C2 = WANGLE / PI
0086 PHIFRAC = 1.0
0087 *
0088 *.... CHECK FOR BOUNDARY INTERFERENCE FROM SURFACE OR BOTTOM
0089 * USING INTERMEDIATE FLOW EQUATION
0090 *
0091 DENBOT = DENINT (0.)
0092 DENUPP = DENINT (DEPTH)
0093 IF (HGTPRT .GT. 0.0) THEN
0094 QBLIM = QBNG (0.) .GE. 0.
0095 ELSE
0096 QBLIM = .TRUE.
0097 ENDIF
0098 QTLIM = QBNG (DEPTH) .GE. 0.
0099 *
0100 *.... DIRECT COMPUTATIONS BASED ON INTERFERENCE

```

Instruction Report E-87-2  
July 1992

VPORT

```

0101 * CHARACTERISTICS
0102 *
0103 IF (QTLIM .AND. QBLIM) GO TO 540
0104 IF (QTLIM) GO TO 500
0105 IF (QBLIM) GO TO 510
0106 IF (.NOT. QTLIM .AND. .NOT. QBLIM) GO TO 540
0107 500 CONTINUE
0108 *
0109 *.... IF ONLY ONE BOUNDARY EXPERIENCES INTERFERENCE, FIND THE
0110 * HEIGHT OF WITHDRAWAL USING SMITH, 1987
0111 *
0112 *.... DETERMINE THE HEIGHT OF THE TRUNCATED PORTION, THE BOUNDARY
0113 * LIMIT, THE SEARCH INTERVAL LIMITS, AND THE FUNCTION SIGN AT
0114 * THE SEARCH LIMITS
0115 *
0116 *.... SURFACE INTERFERENCE
0117 *
0118 SMALLB = DEPTH - HGTPRT
0119 DENLIM = DENUPP
0120 BONLIM = DEPTH
0121 X1 = 0.
0122 X2 = DEPTH
0123 H1 = QSMITH (X1)
0124 GO TO 530
0125 510 CONTINUE
0126 *
0127 *.... BOTTOM INTERFERENCE
0128 *
0129 SMALLB = HGTPRT
0130 DENLIM = DENBOT
0131 BONLIM = 0.
0132 X1 = 0.
0133 X2 = DEPTH
0134 H1 = 1.
0135 530 CONTINUE
0136 *
0137 *.... FIND THE LIMIT USING A HALF-INTERVAL SEARCH
0138 *
0139 *.... INITIALIZE X3
0140 *
0141 X3 = SMALL
0142 *
0143 *.... BEGIN ITERATION
0144 *
0145 DO 560 I = 1, 2 * MAX
0146 X4 = X3
0147 *
0148 *.... ESTABLISH A THIRD POINT BETWEEN TWO EXISTING POINTS
0149 *
0150 X3 = (X1 + X2) / 2.0

```

VPORT

```
0151 *
0152 *.... CALCULATE FUNCTION SIGN AT NEW POINT
0153 *
0154 H3 = QSMITH (X3)
0155 ZONED = ABS (BONLIM - X3)
0156 *
0157 *.... IF NEW POINT IS SAME AS PREVIOUS POINT (WITHIN TOLERANCE),
0158 * ITERATION IS COMPLETE
0159 *
0160 IF (ABS (X4 - X3) .LT. SMALL) GO TO 570
0161 *
0162 *.... USE AS NEW SEARCH LIMITS THE MOST RECENT POINT AND THE
0163 * REMAINING POINT OF OPPOSITE FUNCTION SIGN
0164 *
0165 IF (H1 * H3 .LT. 0.) GO TO 535
0166 X1 = X3
0167 H1 = H3
0168 GO TO 560
0169 535 CONTINUE
0170 X2 = X3
0171 560 CONTINUE
0172 *
0173 *.... CONVERGENCE WAS NOT REACHED
0174 *
0175 CALL ERROR (1500, SUBR, XDUMY, XDUMY1, XDUMY2, XDUMY3)
0176 570 CONTINUE
0177 PHIFRAC = PHI (X3)
0178 *
0179 *.... CALCULATE WITHDRAWAL LIMIT
0180 *
0181 IF (QTLIM .AND. .NOT. QBLIM) HGTLOW = DEPTH - ZONED
0182 IF (QBLIM .AND. .NOT. QTLIM) HGTTOP = ZONED
0183 540 CONTINUE
0184 *
0185 *.... USAGE FOR THE BOHAN AND GRACE EQUATION
0186 * 1. NO BOUNDARY INTERFERENCE
0187 * 2. BOTH BOUNDARIES INTERFERE WITH WITHDRAWAL ZONE
0188 * 3. SINGLE BOUNDARY INTERFERENCE. THEORETICAL LIMIT
0189 * OF ONE INTERFERED WITH MUST BE DETERMINED
0190 * (FREE LIMIT IS DETERMINED ABOVE WITH SMITH EQUATION)
0191 *
0192 IF (QTLIM .AND. .NOT. QBLIM) GO TO 150
0193 *
0194 *.... EMBARK ON DETERMINATION OF LOWER WITHDRAWAL LIMIT
0195 *
0196 *
0197 *.... IF LOWER LIMIT IS WITHIN THE POOL THEN FIND IT WITH A
0198 * HALF-INTERVAL SEARCH
0199 *
0200 *.... INITIAL SEARCH LIMITS ARE X1 =0 AND X2 = HGTPRT
```

Instruction Report E-87-2  
July 1992

VPORT

```

0201 *
0202 X1 = 0.0
0203 *
0204 *.... IF BOTTOM BOUNDARY INTERFERENCE EXISTS (LOWER LIMIT OUTSIDE
0205 * POOL), THEN X1 = - DEPTH
0206 *
0207 IF (QBLIM) X1 = - DEPTH
0208 F1 = QBNG (X1)
0209 DENLIM = DENBOT
0210 X2 = HGTPRT
0211 X3 = -2. * SMALL
0212 ASSIGN 140 TO XXX
0213 110 CONTINUE
0214 *
0215 *.... INITIATE ITERATION PROCESS
0216 *
0217 DO 130 I = 1, MAX
0218 *
0219 *.... ESTABLISH A THIRD POINT BETWEEN THE TWO EXISTING POINTS
0220 *
0221 X4 = X3
0222 X3 = (X1 + X2) / 2.
0223 *
0224 *.... CALCULATE FUNCTION SIGN AT NEW ELEVATION
0225 *
0226 DENLIM = DENINT (X3)
0227 IF (DENLIM .EQ. DENPRT) GO TO XXX
0228 F3 = QBNG (X3)
0229 *
0230 *.... IF NEW POINT IS SAME AS PREVIOUS POINT (WITHIN TOLERANCE)
0231 * THEN SEARCH IS COMPLETE
0232 *
0233 IF (ABS (X4 - X3) .LT. SMALL)
0234 & GO TO XXX, (140, 170)
0235 *
0236 *.... USE AS NEW SEARCH LIMITS THE MOST RECENTLY COMPUTED POINT AND
0237 * THE REMAINING POINT OF OPPOSITE SIGN
0238 *
0239 IF (F1 * F3 .GT. 0.) GO TO 120
0240 X2 = X3
0241 GO TO 130
0242 120 CONTINUE
0243 X1 = X3
0244 F1 = F3
0245 130 CONTINUE
0246 *
0247 *.... CONVERGENCE HAS NOT BEEN REACHED
0248 *
0249 CALL ERROR (1510, SUBR, XDUMY, XDUMY1, XDUMY2, XDUMY3)
0250 140 CONTINUE

```

VPORT

```
0251 *
0252 *.... SET LOWER LIMIT ELEVATION
0253 *
0254 HGTLOW - X3
0255 150 CONTINUE
0256 IF (QBLIM .AND. .NOT. QTLIM) GO TO 180
0257 *
0258 *.... APPLY SAME PROCEDURE FOR DETERMINING UPPER WITHDRAWAL LIMIT
0259 * FOR ORIFICE
0260 *
0261 *.... DETERMINE ELEVATION, LAYER AND FUNCTION SIGN AT SEARCH
0262 * LIMITS. IF NIETHER LIMIT EXPERIENCES INTERFERENCE THE THE
0263 * INITIAL SEARCH LIMITS ARE X1 - HGTPRT AND X2 - DEPTH.
0264 * HOWEVER, IF SURFACE INTERFERENCE EXISTS (UPPER LIMIT OUTSIDE
0265 * POOL), THEN X2 = 2. * DEPTH
0266 *
0267 X1 - HGTPRT
0268 X2 - DEPTH
0269 IF (QTLIM) X2 = 2 * DEPTH
0270 F1 - QBNG (X1)
0271 *
0272 *.... USE THE PRIOR SEARCH PROCEDURE
0273 *
0274 ASSIGN 170 TO XXX
0275 DENLIM - DENUPP
0276 GO TO 110
0277 170 CONTINUE
0278 HGTTOP - X3
0279 180 CONTINUE
0280 *
0281 *.... CALCULATE LOCATION OF MAXIMUM VELOCITY AND THICKNESS OF
0282 * WITHDRAWAL LIMITS
0283 *
0284 185 CONTINUE
0285 ZONE - HGTTOP - HGTLOW
0286 ZTOP - HGTTOP - HGTPRT
0287 ZLOW - HGTPRT - HGTLOW
0288 *
0289 *.... BASED ON BOHAN AND GRACE
0290 *
0291 YVMAX - ZONE * (SIN (1.57 * ZLOW / ZONE)) ** 2
0292 * YVMAX - HGTPRT
0293 *
0294 *.... HEIGHT ABOVE BOTTOM. HARDWARE TO PREVENT MAX VELOCITY
0295 * OUTSIDE THE POOL (HOWINGTON 9-25-91)
0296 *
0297 XVMAX - YVMAX + HGTLOW
0298 IF (XVMAX .LT. 0.0) XVMAX - 0.0
0299 IF (XVMAX .GT. DEPTH) XVMAX - DEPTH
0300 LVMAX - LAYER (XVMAX)
```

Instruction Report E-87-2

July 1992

VPORT

```

0301 *
0302 *.... MAXIMUM VELOCITY OUTSIDE THE POOL
0303 *
0304 IF ((XVMAX .LT. 0.) .OR. (XVMAX .GT. DEPTH))
0305 & CALL ERROR (1520 , SUBR, XDUMY, XDUMY1, XDUMY2,
0306 & XDUMY3)
0307 *
0308 *.... ASSIGN DENSITIES AT LIMITS AND MAXIMUM VELOCITY
0309 *
0310 DVMAX = DENINT (XVMAX)
0311 DENLOW = DENINT (HGTLOW)
0312 DENTOP = DENINT (HGTTOP)
0313 *
0314 *.... WITHDRAWAL LAYER LIMITS
0315 *
0316 IF (HGTLOW .LT. 0.) LOWLIM = LAYER (0.)
0317 IF (HGTLOW .GE. 0.) LOWLIM = LAYER (HGTLOW)
0318 IF (HGTTOP .GE. DEPTH) TOPLIM = ISURF
0319 IF (HGTTOP .LT. DEPTH) TOPLIM = LAYER (HGTTOP)
0320 *
0321 *.... ZERO THE VELOCITY PROFILE FOR THE CURRENT PORT
0322 *
0323 DO 190 I = 1, ISURF
0324 V (I) = 0.
0325 190 CONTINUE
0326 *
0327 *.... IF LOWER WITHDRAWAL LAYERS ARE OF CONSTANT DENSITY THEN
0328 * ASSIGN CONSTANT VELOCITY TO EACH LAYER
0329 *
0330 DENDIF = DENLOW - DVMAX
0331 IF (DENDIF .GT. 0.) GO TO 210
0332 DO 200 I = LOWLIM, LVMAX
0333 V (I) = VMAX
0334 200 CONTINUE
0335 GO TO 240
0336 210 CONTINUE
0337 *
0338 *.... CALCULATE VELOCITY PROFILE FROM LAYER OF MAXIMUM VELOCITY
0339 * TO LOWER LIMIT
0340 *
0341 IF (LOWLIM .EQ. LVMAX) GO TO 240
0342 DO 230 I = LOWLIM, LVMAX
0343 Y1 = DELZ * (LVMAX - I)
0344 DELDEN = DEN (I) - DVMAX
0345 *
0346 *.... BASED ON BOHAN AND GRACE
0347 *
0348 RATIO = Y1 * DELDEN / (ZLOW * DENDIF)
0349 RATIO = AMIN1 (1., RATIO)
0350 V(I) = VMAX * (1. - RATIO) ** 2.0

```

VPORT

```

0351 230 CONTINUE
0352 240 CONTINUE
0353 *
0354 *.... IF UPPER WITHDRAWAL LAYERS ARE OF CONSTANT DENSITY THEN
0355 * ASSIGN CONSTANT VELOCITY TO EACH LAYER
0356 *
0357 DENDIF = DVMAX - DENTOP
0358 IF (DENDIF .GT. 0.) GO TO 260
0359 DO 250 I = LVMAX, TOPLIM
0360 V (I) = VMAX
0361 250 CONTINUE
0362 GO TO 290
0363 260 CONTINUE
0364 *
0365 *.... DETERMINE VELOCITY PROFILE FROM LAYER OF MAXIMUM VELOCITY
0366 * TO UPPER LIMIT
0367 *
0368 IF (LVMAX .EQ. TOPLIM) GO TO 290
0369 DO 280 I = LVMAX, TOPLIM
0370 Y1 = DELZ * (I - LVMAX)
0371 DELDEN = DVMAX - DEN (I)
0372 *
0373 *.... BASED ON BOHAN AND GRACE
0374 *
0375 RATIO = Y1 * DELDEN / (ZTOP * DENDIF)
0376 RATIO = AMIN1 (1., RATIO)
0377 V(I) = VMAX * (1. - RATIO) ** 2.0
0378 280 CONTINUE
0379 290 CONTINUE
0380 *
0381 *.... CONVERT NORMALIZED VELOCITIES TO FLOW RATES, I.E., DETERMINE
0382 * THE WITHDRAWAL FROM EACH LAYER
0383 *
0384 SUM = 0.0
0385 DO 310 I = LOWLIM, TOPLIM
0386 SUM = SUM + V (I) * HGT (I)
0387 310 CONTINUE
0388 VM = FLORAT / SUM
0389 DO 320 I = LOWLIM, TOPLIM
0390 V (I) = V (I) * VM
0391 320 CONTINUE
0392 *
0393 *.... CHECK FOR POINT SINK DESCRIPTION
0394 *
0395 VDIM2 = VDIM / 2.
0396 PRRTOP = HGTPRT + VDIM2
0397 VD2 = VDIM2
0398 IF (PRRTOP .GT. DEPTH) VD2 = DEPTH - HGTPRT
0399 IF (PRRTOP .GT. DEPTH) PRRTOP = DEPTH
0400 PRRTBOT = HGTPRT - VDIM2

```

Instruction Report E-87-2  
July 1992

VPORT

```
0401 IF (PRTBOT .LT. 0. .AND. PRTBOT .GT. -1) PRTBOT = 0.
0402 DRPTOP = DENPRT - DENINT (PRTTOP)
0403 DRPBOT = DENINT (PRTBOT) - DENPRT
0404 *
0405 DRTLIM = DENPRT - DENTOP
0406 DRBLIM = DENLOW - DENPRT
0407 *
0408 IF (DRPBOT .LT. TINY) DRPBOT = TINY
0409 IF (DRPTOP .LT. TINY) DRPTOP = TINY
0410 IF (DRBLIM .LT. TINY) DRBLIM = TINY
0411 IF (DRTLIM .LT. TINY) DRTLIM = TINY
0412 IF (VDIM2 .LT. TINY) VDIM2 = TINY
0413 IF (VD2 .LT. TINY) VD2 = TINY
0414 *
0415 *.... EMPIRICAL EQUATIONS FOR POINT SINK VERIFICATION
0416 *
0417 SINK1 = (DRBLIM) * ZLOW / (DRPBOT * VDIM2)
0418 SINK2 = (DRTLIM) * ZTOP / (DRPTOP * VD2)
0419 QSINK1 = SINK1 .GT. 3.0
0420 QSINK2 = SINK2 .GT. 3.0
0421 RETURN
0422 END
```

VWEIR

```

0001 SUBROUTINE VWEIR
0002 *****
0003 *
0004 * S U B R O U T I N E V W E I R *
0005 *
0006 *****
0007 *
0008 *.... CALCULATE WITHDRAWAL LIMITS AND VELOCITY PROFILE FOR
0009 * WEIR FLOW
0010 *
0011 COMMON / AA / QMETER, NSETS, G, HEADING(18), TITLE(18)
0012 COMMON / CC / DELZ, INTER, SURFACE, BOTTOM
0013 COMMON / DD / WTHETA (5), WANGLE
0014 COMMON / GG / COEF, QSUB, QQUAL
0015 COMMON / II / NUMD, DEN (100), YD(100), QDEN, DENPRT
0016 COMMON / LL / ISURF, HGT (100), DEPTH, Y (100)
0017 COMMON / MM / SUMOUT, VEL (100), FLORAT
0018 COMMON / NN / HGTprt, VDIM, QTLIM, QBLIM, QSINK1, QSINK2,
0019 & QSHIFT
0020 COMMON / OO / LENGTH, CREST, HDIM
0021 COMMON / PP / LOWLIM, TOPLIM, HGTLOW, HGTTOP, V (100), VM
0022 *
0023 LOGICAL QSUB, QMETER, QSHIFT, QBLIM, QTLIM, Q1, Q2, QZ
0024 *
0025 REAL LENGTH
0026 INTEGER TOPLIM
0027 *
0028 CHARACTER*4 XDUMY, XDUMY1, XDUMY2, XDUMY3
0029 CHARACTER*6 SUBR
0030 *
0031 DATA A, B / 4.35, -1.04 /
0032 DATA VMAX, ITMAX / 1., 10 /
0033 DATA XDUMY, XDUMY1, XDUMY2, XDUMY3 / 4 * '0' /
0034 DATA SUBR / 'VWEIR' /
0035 *
0036 LAYER (X) = 1 + X/DELZ
0037 *
0038 *.... FUNCTION STATEMENTS TO SOLVE FOR LOWER WITHDRAWAL LIMITS
0039
0040 *
0041 SIZE (X) = ABS (CREST - X)
0042 RWEIR (Z) = SQRT (Z + HEAD) * (1 + Z / HEAD)
0043 R2WEIR (Z) = SQRT (Z + HEAD)
0044 *
0045 *.... BASED ON DORTCH AND WILHELMS
0046 *
0047 FWEIR (X) = AVGVEL + C * RWEIR (SIZE (X)) *
0048 & SQRT (G * ABS (1. - DENINT (X) / WRDEN))
0049 & + D * R2WEIR (SIZE(X)) *
0050 & SQRT (G * ABS (1. - DENINT(X) / WRDEN))

```

Instruction Report E-87-2  
July 1992

VWEIR

```

0051 *
0052 *.... TOLERANCE, 10% OF THE LAYER THICKNESS
0053 *
0054 SMALL = 0.10 * DELZ
0055 *
0056 *.... CHECK TO SEE IF ENTERING VWEIR FROM SUBROUTINE SHIFT
0057 *
0058 IF (QSHIFT) GO TO 145
0059 IF (QSUB) GO TO 85
0060 *
0061 *.... CALCULATE EXPONENT FOR USE WITH FREE WEIR
0062 *
0063 EXPNT = A + B * COEF
0064 IF (ABS (COEF - 3.00) .LT. .01) EXPNT = 1.5
0065 IF (ABS (COEF - 3.33) .LT. .01) EXPNT = 0.5
0066 IF (ABS (COEF - 4.10) .LT. .01) EXPNT = 0.2
0067 85 CONTINUE
0068 C = .54
0069 D = 0.
0070 QZ = .FALSE.
0071 *
0072 *.... CALCULATE AVERAGE VELOCITY OVER THE WEIR IN FT/SEC
0073 *
0074 VMAX = 1.
0075 HEAD = DEPTH - CREST
0076 AVGVEL = FLORAT / (HEAD * LENGTH)
0077 *
0078 *.... CHECK FOR INTERFERENCE FROM BOTTOM. ASSUMED SURFACE
0079 * INTERFERENCE
0080 *
0081 90 CONTINUE
0082 WRDEN = DENINT (CREST)
0083 QBLIM = FWEIR (0.) .GE. 0.
0084 QTLIM = .TRUE.
0085 *
0086 *.... EMBARK ON DETERMINATION OF LOWER WITHDRAWAL LIMIT
0087 *
0088 IF (.NOT. QBLIM) GO TO 100
0089 *
0090 *.... IF BOTTOM INTERFERENCE EXISTS THEN SET LOWER LIMIT
0091 * AT THE BOTTOM
0092 *
0093 HGTLOW = 0.
0094 LOWLIM = 1
0095 GO TO 140
0096 100 CONTINUE
0097 *
0098 *.... IF LOWER LIMIT IS WITHIN THE POOL THEN FIND IT WITH A
0099 * HALF-INTERVAL SEARCH
0100 *

```

VWEIR

```
0101 *.... DETERMINE ELEVATION, LAYER, FUNCTION VALUE, AND FUNCTION SIGN
0102 * AT EACH SEARCH LIMIT X1 POOL BOTTOM AND X2 WEIR CREST
0103 *
0104 X1 = 0.
0105 F1 = FWEIR (X1)
0106 Q1 = F1 .GT. 0.
0107 X2 = CREST
0108 F2 = AVGVEL
0109 Q2 = F2 .GT. 0.
0110 X3 = - 2. * SMALL
0111 *
0112 *.... FUNCTION MUST BE POSITIVE AT THE WEIR LEVEL AND NEGATIVE
0113 * AT THE BOTTOM
0114 *
0115 IF (Q1 .OR. .NOT. Q2)
0116 & CALL ERROR (1600 , SUBR, XDUMY, XDUMY1, XDUMY2,
0117 & XDUMY3)
0118 *
0119 *.... INITIATE ITERATION PROCESS
0120 *
0121 DO 120 I = 1, ITMAX
0122 *
0123 *.... ESTABLISH A THIRD POINT BETWEEN THE TWO EXISTING POINTS
0124 *
0125 X4 = X3
0126 X3 = (X1 + X2) / 2
0127 *
0128 *.... CALCULATE FUNCTION SIGN AT NEW ELEVATION
0129 *
0130 F3 = FWEIR (X3)
0131 *
0132 *.... IF NEW POINT IS SAME AS PREVIOUS POINT (WITHIN TOLERANCE)
0133 * THEN SEARCH IS COMPLETE
0134 *
0135 IF (ABS (X4 - X3) LT SMALL) GO TO 130
0136 *
0137 *.... USE AS NEW SEARCH LIMITS THE MOST RECENTLY COMPUTED POINT
0138 * AND THE REMAINING POINT OF OPPOSITE SIGN
0139 *
0140 IF (F1 * F3 GT 0) GO TO 110
0141 X2 = X3
0142 F2 = F3
0143 GO TO 120
0144 110 CONTINUE
0145 X1 = X3
0146 F1 = F3
0147 120 CONTINUE
0148 *
0149 * CONVERGENCE HAS NOT BEEN REACHED
0150 *
```

Instruction Report E-87-2  
July 1992

VWEIR

```

0151 CALL ERROR (1610, SUBR, XDUMY, XDUMY1, XDUMY2, XDUMY3)
0152 130 CONTINUE
0153 *
0154 *..... CHECK FOR (Z + H) / H LESS THAN 2.0. IF TRUE, REASSIGN
0155 * COEFFICIENTS C AND D AND REPEAT ITERATION PROCESS
0156 *
0157 IF (QZ) GO TO 136
0158 ZLOW = CREST - X3
0159 XCHECK = (ZLOW + HEAD) / HEAD
0160 IF (XCHECK .GE. 2.0) GO TO 135
0161 C = .78
0162 D = .70
0163 QZ = .TRUE.
0164 GO TO 90
0165 135 CONTINUE
0166 136 CONTINUE
0167 *
0168 *..... SET LOWER LIMIT ELEVATION AND LAYER
0169 *
0170 HGTLOW = X3
0171 LOWLIM = LAYER (X3)
0172 140 CONTINUE
0173 *
0174 *..... SET UPPER LIMIT AT SURFACE
0175 *
0176 145 CONTINUE
0177 HGTTOP = DEPTH
0178 TOPLIM = ISURF
0179 *
0180 *..... CALCULATE LOCATION OF MAXIMUM VELOCITY
0181 *
0182 ZONE = HGTTOP - HGTLOW
0183 ZLOW = CREST - HGTLOW
0184 *
0185 *..... IF WEIR IS FREE, MAXIMUM VELOCITY IS AT THE SURFACE
0186 *
0187 IF (NOT QSUB) YVMAX = ZONE
0188 *
0189 *..... BASED ON BOHAN AND GRACE
0190 *
0191 IF (QSUB) YVMAX = ZONE * SIN (1.57 * ZLOW / ZONE) **2
0192 *
0193 *..... COMPUTE THICKNESS OF WITHDRAWAL ZONE
0194 *
0195 *..... HEIGHT OF MAX VELOCITY ABOVE THE BOTTOM
0196 *
0197 XVMAX = YVMAX + HGTLOW
0198 *
0199 *..... LAYER NO LOCATION OF MAX VELOCITY
0200 *

```

VWEIR

```

0201 LVMAX = LAYER (XVMAX)
0202 *
0203 *.... DENSITY AT LAYER OF MAX. VELOCITY
0204 *
0205 DVMAX = DENINT (XVMAX)
0206 *
0207 *.... DETERMINE DISTANCE BETWEEN PORT ELEVATION AND LOWER AND
0208 * UPPER LIMITS RESPECTIVELY
0209 *
0210 YLOW = DELZ * (LVMAX - LOWLIM)
0211 YTOP = DELZ * (TOPLIM - LVMAX)
0212 *
0213 *.... DETERMINE DENSITY AT LIMITS
0214 *
0215 DENLOW = DENINT (HGTLOW)
0216 DENTOP = DENINT (HGTTOP)
0217 *
0218 *.... CALCULATE MAXIMUM VELOCITY
0219 *
0220 VMAX = 1.
0221 *
0222 *.... ZERO THE VELOCITY PROFILE
0223 *
0224 DO 150 I = 1, ISURF
0225 V (I) = 0
0226 150 CONTINUE
0227 *
0228 *.... IF LOWER WITHDRAWAL LAYERS ARE OF CONSTANT DENSITY THEN
0229 * ASSIGN CONSTANT VELOCITY TO EACH LAYER
0230 *
0231 IF (LVMAX .EQ. LOWLIM) GO TO 200
0232 DENDIF = DENLOW - DVMAX
0233 IF (DENDIF .GT. 0) GO TO 170
0234 DO 160 I = LOWLIM, LVMAX
0235 V (I) = VMAX
0236 160 CONTINUE
0237 GO TO 200
0238 170 CONTINUE
0239 *
0240 *.... CALCULATE VELOCITY PROFILE FROM LAYER OF MAXIMUM VELOCITY
0241 * TO LOWER LIMIT
0242 *
0243 DO 190 I = LOWLIM, LVMAX
0244 Y1 = DELZ * (LVMAX - I)
0245 DELDEN = DEN (I) - DVMAX
0246 RATIO = Y1 * DELDEN / (YLOW * DENDIF)
0247 RATIO = AMIN1 (1., RATIO)
0248 IF (QBLIM) GO TO 180
0249 P = 3.0
0250 *

```

Instruction Report E-87-2  
July 1992

VWEIR

```

0251 *.... IF WEIR IS SUBMERGED
0252 *
0253 IF (QSUB) V (I) = VMAX * (1. - RATIO) ** P
0254 *
0255 *.... IF WEIR IS FREE
0256 *
0257 IF (NOT. QSUB) V (I) = VMAX *
0258 & (1. - RATIO ** EXPNT)
0259 GO TO 190
0260 180 CONTINUE
0261 *
0262 *.... IF BOTTOM INTERFERENCE
0263 *
0264 V (I) = VMAX * (1. - RATIO ** 2)
0265 190 CONTINUE
0266 200 CONTINUE
0267 *
0268 *.... IF FREE WEIR, GO TO 260
0269 *
0270 IF (.NOT. QSUB) GO TO 260
0271 *
0272 *.... IF UPPER WITHDRAWAL LAYERS ARE OF CONSTANT DENSITY THEN
0273 * ASSIGN CONSTANT VELOCITY TO EACH LAYER
0274 *
0275 IF (LVMAX .EQ. TOPLIM) GO TO 260
0276 DENDIF = DVMAX - DENTOP
0277 IF (DENDIF .GT. 0.) GO TO 220
0278 DO 210 I = LVMAX, TOPLIM
0279 V (I) = VMAX
0280 210 CONTINUE
0281 GO TO 250
0282 220 CONTINUE
0283 *
0284 *.... DETERMINE VELOCITY PROFILE FROM LAYER OF MAXIMUM VELOCITY
0285 * TO UPPER LIMIT
0286 *
0287 DO 240 I = LVMAX, TOPLIM
0288 Y1 = DELZ * (I - LVMAX)
0289 DELDEN = DVMAX - DEN (I)
0290 RATIO = Y1 * DELDEN / (YTOP * DENDIF)
0291 RATIO = AMIN1 (1., RATIO)
0292 V (I) = VMAX * (1. - RATIO ** 2)
0293 240 CONTINUE
0294 250 CONTINUE
0295 260 CONTINUE
0296 *
0297 *.... CONVERT NORMALIZED VELOCITIES TO FLOW RATES, I.E.,
0298 * DETERMINE WITHDRAWAL FROM EACH LAYER
0299 *
0300 SUM = 0.0

```

VWEIR

```
0301 DO 270 I = LOWLIM, TOPLIM
0302 SUM = SUM + V (I) * HGT (I)
0303 270 CONTINUE
0304 VM = FLORAT / SUM
0305 DO 280 I = LOWLIM, TOPLIM
0306 V (I) = V (I) * VM
0307 280 CONTINUE
0308 RETURN
0309 END
```

XPRINT

```

0001 SUBROUTINE XPRINT
0002 *****
0003 *
0004 * S U B R O U T I N E X P R I N T *
0005 *
0006 *****
0007 *
0008 *.... PRINTS OUTPUT INFORMATION
0009 *
0010 COMMON / AA / QMETR, NSETS, G, HEADING (18), TITLE (18)
0011 COMMON / BB / IFILE, KFILE
0012 COMMON / CC / DELZ, INTER, SURFACE, BOTTOM
0013 COMMON / DD / WTHETA (5), WANGLE
0014 COMMON / EE / NPORTS, QPORT, QWEIR, QPLOT, QPWEIR
0015 COMMON / FF / PVDIM (5), PHGT (5), FLOW (5), PHDIM (5)
0016 COMMON / HH / WRLNG, WRHGT, WRFLOW
0017 COMMON / II / NUMD, DEN (100), YD (100), QDEN, DENPRT
0018 COMMON / JJ / NUMT, QCENT, TEMP (100), YT (100), QTEMP
0019 COMMON / KK / NQUAL, NUMQ (4), NAMEQ (5,4),
0020 & QUAL (4, 100), YQ (4, 100)
0021 COMMON / LL / ISURF, HGT (100), DEPTH, Y (100)
0022 COMMON / MM / SUMOUT, VEL (100), FLORAT
0023 COMMON / NN / HGTPRT, VDIM, QTLIM, QBLIM, QSINK1,
0024 & QSINK2, QSHIFT
0025 COMMON / QQ / VS (100, 6), NOUTS
0026 COMMON / RR / ZUP (6), ZDN (6), LTOP (6), LLOW (6)
0027 COMMON / SS / WTHDRW (100), DENOUT, TEMOUT, QALOUT (4)
0028 *
0029 CHARACTER*4 HEADING, TITLE, NAMEQ
0030 *
0031 LOGICAL QMETR, QPORT, QWEIR, QCENT, QTEMP, QPLOT
0032 LOGICAL QSINK1, QSINK2, QPWEIR
0033 *
0034 CHARACTER*6 XMETERS, DIST
0035 CHARACTER*4 XFEET
0036 *
0037 DATA XFEET, XMETERS / 'FEET', 'METERS' /
0038 *
0039 TEMFUN (T) = 9. / 5. * T + 32.
0040 *
0041 *.... PRINT HEADINGS AND SUMMARY INFORMATION
0042 *
0043 WRITE (KFILE, 510) TITLE
0044 WRITE (KFILE, 520) HEADING
0045 *
0046 *.... UNITS
0047 *
0048 DIST = XFEET
0049 IF (QMETR) DIST = XMETERS
0050 WRITE (KFILE, 500) DIST

```

XPRINT

```

0051 IF (.NOT. QPORT) GO TO 110
0052 *
0053 *.... PORT INFORMATION
0054 *
0055 DO 100 L = 1, NPORTS
0056 PELEV = PHGT(L) + BOTTOM
0057 WRITE (KFILE, 530) PELEV, PVDIM (L), FLOW (L),
0058 & WTHETA (L)
0059 100 CONTINUE
0060 110 CONTINUE
0061 *
0062 *.... WEIR INFORMATION
0063 *
0064 IF (QWEIR) WELE = WRHGT + BOTTOM
0065 IF (QWEIR) WRITE (KFILE, 540) WELE, WRLNG, WRFLOW
0066 *
0067 *.... FLOW RATE INFORMATION
0068 *
0069 WRITE (KFILE, 550) SUMOUT
0070 *
0071 *.... WITHDRAWAL LIMIT INFORMATION
0072 *
0073 *.... THEORETICAL LIMITS
0074 *
0075 ZUPEL = ZUP (NOUTS) + BOTTOM
0076 ZDNEL = ZDN (1) + BOTTOM
0077 *
0078 *.... ACTUAL LIMITS
0079 *
0080 AWLUPP = AMIN1 (DEPTH, ZUP (NOUTS))
0081 AWLBOT = AMAX1 (0.0 , ZDN (1))
0082 AZUPEL = AWLUPP + BOTTOM
0083 AZDNEL = AWLBOT + BOTTOM
0084 WRITE (KFILE, 555) AWLBOT , AZDNEL
0085 WRITE (KFILE, 560) ZDN (1) , ZDNEL
0086 WRITE (KFILE, 565) AWLUPP , AZUPEL
0087 WRITE (KFILE, 570) ZUP (NOUTS) , ZUPEL
0088 *
0089 *.... RELEASE DENSITY
0090 *
0091 WRITE (KFILE, 580) DENOUT
0092 IF (.NOT. QTEMP) GO TO 120
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Instruction Report E-87-2  
July 1992

XPRINT

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0101 *.... RELEASE QUALITY PARAMETER VALUE
0102 *
0103 WRITE(KFILE, 600) ((NAMEQ (NM, J), NM = 1, 5),
0104 & QALOUT (J), J = 1, NQUAL)
0105 130 CONTINUE
0106 *
0107 *.... PORT MODELED AS WEIR
0108 *
0109 IF (QPWEIR) WRITE (KFILE, 607)
0110 *
0111 *.... POINT SINK VERIFICATION INFORMATION
0112 *
0113 IF (.NOT. QSINK1) WRITE (KFILE, 605)
0114 IF (.NOT. QSINK2) WRITE (KFILE, 606)
0115 *
0116 *.... PRINT TABULAR INFORMATION
0117 *
0118 IF (.NOT. QTEMP .AND. NQUAL .EQ. 0) THEN
0119 WRITE (KFILE, 610)
0120 ELSEIF (QTEMP .AND. NQUAL .EQ. 0) THEN
0121 WRITE (KFILE, 620)
0122 ELSEIF (.NOT. QTEMP .AND. NQUAL .GT. 0) THEN
0123 WRITE (KFILE, 630) ((NAMEQ (NM , J), NM = 1, 3),
0124 & J = 1, NQUAL)
0125 ELSE
0126 WRITE (KFILE, 635) ((NAMEQ (NM , J), NM = 1, 3),
0127 & J = 1, NQUAL)
0128 ENDIF
0129 *
0130 DO 170 I = 1, ISURF, INTER
0131 K = ISURF - I + 1
0132 ELEV = Y (K) + BOTTOM
0133 DEEP = SURFACE - ELEV
0134 *
0135 *.... ELEVATION, DENSITIES, NORMALIZED VELOCITY, AND
0136 * LAYER WITHDRAWAL
0137 *
0138 IF (.NOT. QTEMP .AND. NQUAL .EQ. 0) THEN
0139 WRITE (KFILE, 640) ELEV, DEEP, DEN (K),
0140 & VEL (K), WTHDRW (K)
0141 ELSEIF (QTEMP .AND. NQUAL .EQ. 0) THEN
0142 IF (.NOT. QCENT) TEMP (K) = TEMFUN (TEMP (K))
0143 WRITE (KFILE, 650) ELEV, DEEP, DEN (K),
0144 & VEL (K), WTHDRW (K), TEMP (K)
0145 ELSEIF (.NOT. QTEMP .AND. NQUAL .GT. 0) THEN
0146 WRITE (KFILE, 660) ELEV, DEEP, DEN (K),
0147 & VEL (K), WTHDRW (K),
0148 & (QUAL (J , K), J = 1, NQUAL)
0149 ELSE
0150 WRITE (KFILE, 670) ELEV, DEEP, DEN (K),

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XPRINT

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0151 & VEL (K), WTHDRW (K), TEMP (K) ,
0152 & (QUAL (J , K), J = 1, NQUAL)
0153 ENDIF
0154 170 CONTINUE
0155 *
0156 *.... PLOT DENSITY AND VELOCITY PROFILES
0157 *
0158 CALL DVPLLOT
0159 *
0160 RETURN
0161 500 FORMAT (// 20X, 12HUNITS ARE IN, 1X, A6)
0162 510 FORMAT (1H1 // 8X, 18A4)
0163 520 FORMAT (//// 8X, 18A4)
0164 530 FORMAT (// 20X, 14HPORT ELEVATION, 2X, F9.3 / 20X,
0165 & 23HPORT VERTICAL DIMENSION, 2X, F10.3 / 20X,
0166 & 31HDISCHARGE, VOLUME FLOW PER SEC., 2X, F11.4
0167 & / 20X, 21HWITHDRAWAL ANGLE, RAD, 2X , F6.4)
0168 540 FORMAT (// 20X, 20HWEIR CREST ELEVATION, 2X, F9.3 /
0169 & 20X, 11HWEIR LENGHT, 2X, F10.3 / 20X,
0170 & 31HDISCHARGE, VOLUME FLOW PER SEC., 2X, F11.4)
0171 550 FORMAT (/// 20X, 31HTOTAL DISCHARGE, VOLUME PER SEC,
0172 & 2X, F11.4)
0173 555 FORMAT (// 20X, 33HLOWER WITHDRAWAL LIMIT (ACTUAL),
0174 & 20H HEIGHT ABOVE BOTTOM, 7X, F9.3, 4X,
0175 & 9HELEVATION, 2X, F9.3)
0176 560 FORMAT (20X, 38HLOWER WITHDRAWAL LIMIT (THEORETICAL),
0177 & 20H HEIGHT ABOVE BOTTOM, 2X, F9.3, 4X,
0178 & 9HELEVATION, 2X, F9.3)
0179 565 FORMAT (20X, 33HUPPER WITHDRAWAL LIMIT (ACTUAL),
0180 & 20H HEIGHT ABOVE BOTTOM, 7X, F9.3, 4X,
0181 & 9HELEVATION, 2X, F9.3)
0182 570 FORMAT (20X, 38HUPPER WITHDRAWAL LIMIT (THEORETICAL),
0183 & 20H HEIGHT ABOVE BOTTOM, 2X, F9.3, 4X,
0184 & 9HELEVATION, 2X, F9.3)
0185 580 FORMAT (20X, 15HOUTFLOW DENSITY, 2X, F7.5, 2X, 4HG/CC)
0186 590 FORMAT (20X, 19HOUTFLOW TEMPERATURE, 2X, F6.2)
0187 600 FORMAT (20X, 24HOUTFLOW CONCENTRATION OF, 1X, 5A4,
0188 & 2X, F8.2)
0189 605 FORMAT (/, 20X, 10H***** , 5X, 18HWARNING-POINT SINK,
0190 & 41HDESCRIPTION NOT ADEQUATE FOR LOWER LIMIT, 5X,
0191 & 10H*****)
0192 606 FORMAT (/, 20X, 10H***** , 5X, 18HWARNING-POINT SINK,
0193 & 41H DESCRIPTION NOT ADEQUATE FOR UPPER LIMIT, 5X,
0194 & 10H*****)
0195 607 FORMAT (/, 20X, 5H***** , 3X, 'PARTIALLY SUBMERGED',
0196 & ' PORT RESPONDED AS A WEIR FOR THIS CONDITION',
0197 & ' SO VWEIR WAS USED')
0198 610 FORMAT (1H1 // 2X, 9HELEVATION, 3X, 5HDEPTH, 4X,
0199 & 7HDENSITY, 3X, 10HNORM. VEL., 4X, 4HFLOW)
0200 620 FORMAT (1H1 // 2X, 9HELEVATION, 3X, 5HDEPTH, 4X,

```

Instruction Report E-87-2  
July 1992

XPRINT

```
0201 & 7HDENSITY, 3X, 10HNORM. VEL., 4X, 4HFLOW,
0202 & 13X, 11HTEMPERATURE)
0203 630 FORMAT (1H1 // 2X, 9HELEVATION, 3X, 5HDEPTH, 4X,
0204 & 7HDENSITY, 3X, 10HNORM. VEL., 4X, 4HFLOW,
0205 & 24X, 4(2X, 3A4))
0206 635 FORMAT (1H1 // 2X, 9HELEVATION, 3X, 5HDEPTH, 4X,
0207 & 7HDENSITY, 3X, 10HNORM. VEL., 4X, 4HFLOW,
0208 & 13X, 11HTEMPERATURE, 4(2X, 3A4))
0209 640 FORMAT (2X, F9.3, 4X, F6.2, 4X, F7.5,
0210 & 5X, F6.4, 3X, F9.4)
0211 650 FORMAT (2X, F9.3, 4X, F6.2, 4X, F7.5,
0212 & 5X, F6.4, 3X, F9.4, 15X, F5.2)
0213 660 FORMAT (2X, F9.3, 4X, F6.2, 4X, F7.5,
0214 & 5X, F6.4, 3X, F9.4, 20X, 4F13.2)
0215 670 FORMAT (2X, F9.3, 4X, F6.2, 4X, F7.5,
0216 & 5X, F6.4, 3X, F9.4, 15X, F5.2, 4F13.2)
0217 END
```

XREAD

```

0001 SUBROUTINE XREAD
0002 *****
0003 *
0004 * S U B R O U T I N E X R E A D *
0005 *
0006 *****
0007 *
0008 *.... THIS SUBROUTINE READS ALL INPUT DATA AND CONSTRUCTS
0009 * FULL TABLES
0010 *
0011 COMMON / AA / QMETR, NSETS, G, HEADING (18), TITLE (18)
0012 COMMON / BB / IFILE, KFILE
0013 COMMON / CC / DELZ, INTER, SURFACE, BOTTOM
0014 COMMON / DD / WTHETA (5), WANGLE
0015 COMMON / EE / NPORTS, QPORT, QWEIR, QPLOT, QPWEIR
0016 COMMON / FF / PVDIM (5), PHGT (5), FLOW (5), PHDIM (5)
0017 COMMON / GG / COEF, QSUB, QQUAL
0018 COMMON / HH / WRLNG, WRHGT, WRFLOW
0019 COMMON / II / NUMD, DEN (100), YD (100), QDEN, DENPRT
0020 COMMON / JJ / NUMT, QCENT, TEMP (100), YT (100), QTEMP
0021 COMMON / KK / NQUAL, NUMQ (4), NAMEQ (5,4),
0022 & QUAL (4,100), YQ (4,100)
0023 COMMON / LL / ISURF, HGT (100), DEPTH, Y (100)
0024 COMMON / NN / HGTPRT, VDIM, QTLIM, QBLIM, QSINK1,
0025 & QSINK2, QSHIFT
0026 COMMON / TT / QVENT, QAERA, QTWFUN, TWEL
0027 *
0028 DIMENSION DUMMY (20)
0029 DIMENSION DUMQUAL (100), DUMYQ (100)
0030 *
0031 INTEGER TABTYP
0032 *
0033 CHARACTER*4 CHECK, CHECK1, CHECK2,
0034 & HEADING, TITLE, NAMEQ,
0035 & XDATA, XPRIN, XENGL, XMETR, XELEV, XDEPT,
0036 & XHEIG, XTHIC, XINTE, XSURF, XBOTT,
0037 & XNUMB, XPORT, XWEIR, XVDIM, XFLOW,
0038 & XFREE, XSUBM, XCOEF, XLENG, XDENS, XTEMP,
0039 & XQUAL, XFAHR, XCENT, XTABL, XSTOP, XHDIM,
0040 & XTURB, XGATE, XFUNC, XTAIL, XDISS,
0041 & DUMMY, UNITS, XANGL
0042 CHARACTER*6 SUBR
0043 *
0044 LOGICAL QECHO , QMETR, QPORT , QWEIR , QSUB , QPLOT,
0045 & QPWEIR, QDEN , QCENT , QTABL , QTEMP , QQUAL
0046 LOGICAL QVENT , QAERA, QTWFUN, QFIRST, QSINK1, QSINK2
0047 *
0048 DATA XDATA, XPRIN, XENGL / 'DATA', 'PRIN', 'ENGL' /
0049 DATA XMETR, XELEV, XDEPT / 'METR', 'ELEV', 'DEPT' /
0050 DATA XHEIG, XTHIC / 'HEIG', 'THIC' /

```

Instruction Report E-87-2  
July 1992

XREAD

```

0051 DATA XINTE, XSURF, XBOTT / 'INTE', 'SURF', 'BOTT' /
0052 DATA XNUMB, XPORT, XGATE / 'NUMB', 'PORT', 'GATE' /
0053 DATA XWEIR, XVDIM, XFLOW / 'WEIR', 'VDIM', 'FLOW' /
0054 DATA XFREE, XSUBM, XCOEF / 'FREE', 'SUBM', 'COEF' /
0055 DATA XLENG, XDENS, XTEMP / 'LENG', 'DENS', 'TEMP' /
0056 DATA XQUAL, XFAHR, XCENT / 'QUAL', 'FAHR', 'CENT' /
0057 DATA XTABL, XSTOP, XANGL / 'TABL', 'STOP', 'ANGL' /
0058 DATA XHDIM, XDISS / 'HDIM', 'DISS' /
0059 DATA XTURB, XTAIL, XFUNC / 'TURB', 'TAIL', 'FUNC' /
0060 DATA QFIRST / .FALSE. /
0061 DATA XDUMY, XDUMY1, XDUMY2, XDUMY3 / 4 * '0' /
0062 DATA SUBR / 'XREAD' /
0063 *
0064 *.... PROGRAM CONTROL PARAMETERS
0065 *
0066 IF (QFIRST) GO TO 145
0067 QFIRST = .TRUE.
0068 *
0069 *.... INPUT FILE TITLE
0070 *
0071 READ (IFILE, 610) TITLE
0072 *
0073 *.... NUMBER OF DATA SETS
0074 *
0075 READ (IFILE, 620) CHECK, NSETS
0076 IF (CHECK .NE. XDATA)
0077 & CALL ERROR (1010 , SUBR, CHECK, XDATA , XDUMY2,
0078 & XDUMY3)
0079 *
0080 *.... ECHO PRINT
0081 *
0082 QECHO = .FALSE.
0083 READ (IFILE, 610) CHECK
0084 QECHO = CHECK .EQ. XPRIN
0085 IF (.NOT. QECHO) GO TO 140
0086 QECHO = .FALSE.
0087 MFILE = IFILE
0088 REWIND MFILE
0089 WRITE (KFILE, 600)
0090 *
0091 *.... INITIALIZE LINE NUMBERS. ECHO PRINT FILE
0092 *
0093 LINE = 1000
0094 100 CONTINUE
0095 *
0096 *.... PRINT LINE OF INPUT TO OUTPUT WITH EACH LOOP
0097 *
0098 READ (MFILE, 610, END = 110) DUMMY
0099 WRITE (KFILE, 630) LINE, DUMMY
0100 *
```

XREAD

```

0101 *.... INCREMENT LINE NUMBER
0102 *
0103 LINE = LINE + 10
0104 GO TO 100
0105 110 CONTINUE
0106 *
0107 REWIND MFILE
0108 *
0109 120 CONTINUE
0110 *
0111 *.... INCREMENT FILE POINTER TO PRIOR INPUT LINE
0112 *
0113 IK = 3
0114 DO 130 I = 1, IK
0115 READ (IFILE, 610) DUMMY
0116 130 CONTINUE
0117 140 CONTINUE
0118 RETURN
0119 *
0120 *.... ENTRY POINT TO READ THE INDIVIDUAL DATA SETS
0121 *
0122 145 CONTINUE
0123 *
0124 *.... INITIALIZE VARIABLES
0125 *
0126 QSINK1 = .TRUE.
0127 QSINK2 = .TRUE.
0128 QPWEIR = .FALSE.
0129 QMETR = .FALSE.
0130 QPORT = .FALSE.
0131 QWEIR = .FALSE.
0132 QTEMP = .FALSE.
0133 QSUB = .FALSE.
0134 QDEN = .FALSE.
0135 QCENT = .FALSE.
0136 QTAB1 = .FALSE.
0137 QVENT = .FALSE.
0138 QAERA = .FALSE.
0139 QTWFUN = .FALSE.
0140 NPORTS = 0
0141 NQUAL = 0
0142 G = 32.18
0143 *
0144 *.... DATA SET HEADING
0145 *
0146 READ (IFILE, 610) HEADING
0147 *
0148 *.... METRIC OR ENGLISH UNITS
0149 *
0150 READ (IFILE, 610) CHECK

```

Instruction Report E-87-2  
July 1992

XREAD

```

0151 IF (CHECK .NE. XMETR .AND.
0152 & CHECK .NE. XENGL)
0153 & CALL ERROR (1020 , SUBR, CHECK, XENGL, XMETR,
0154 & XDUMY3)
0155 QMETR = CHECK .EQ. XMETR
0156 IF (QMETR) G = 9.807
0157 *
0158 *.... FORM OF INPUT TABLES
0159 *
0160 READ (IFILE, 620) CHECK, TABTYP
0161 IF (CHECK .NE. XTABL)
0162 & CALL ERROR (1030 , SUBR, CHECK, XTABL, XDUMY2,
0163 & XDUMY3)
0164 QTABL = TABTYP .EQ. 1
0165 *
0166 *.... LAYER THICKNESS
0167 *
0168 READ (IFILE, 650) CHECK, DELZ
0169 IF (CHECK .NE. XTHIC)
0170 & CALL ERROR (1040 , SUBR, CHECK, XTHIC, XDUMY2,
0171 & XDUMY3)
0172 *
0173 *.... LAYER INTERVALS FOR WHICH OUTPUT INFO IS DESIRED
0174 *
0175 READ (IFILE, 620) CHECK, INTER
0176 IF (CHECK .NE. XINTE)
0177 & CALL ERROR (1050 , SUBR, CHECK, XINTE, XDUMY2,
0178 & XDUMY3)
0179 *
0180 *.... SURFACE ELEVATION
0181 *
0182 READ (IFILE, 650) CHECK, SURFACE
0183 IF (CHECK .NE. XSURF)
0184 & CALL ERROR (1060 , SUBR, CHECK, XSURF, XDUMY2,
0185 & XDUMY3)
0186 *
0187 *.... BOTTOM ELEVATION
0188 *
0189 READ (IFILE, 650) CHECK, BOTTOM
0190 IF (CHECK .NE. XBOTT)
0191 & CALL ERROR (1070 , SUBR, CHECK, XBOTT, XDUMY2,
0192 & XDUMY3)
0193 *
0194 *.... CONSTRUCT LAYERS
0195 *
0196 DEPTH = SURFACE - BOTTOM
0197 *
0198 *.... CALCULATE NUMBER OF LAYERS
0199 *
0200 ISURF = (DEPTH / DELZ) + .999

```

XREAD

```

0201 IF (ISURF .GT. 100)
0202 & CALL ERROR (1080 , SUBR, XDUMY, XDUMY1, XDUMY2,
0203 & XDUMY3)
0204 *
0205 *.... PERCENTAGE OF LAYER FILLED WITH WATER
0206 *
0207 DO 150 I = 1, ISURF
0208 HGT (I) = 1.0
0209 Y (I) = (DELZ * FLOAT (I)) - (.5 * DELZ)
0210 150 CONTINUE
0211 HGT (ISURF) = (DEPTH - (DELZ * (ISURF - 1)))
0212 & / DELZ
0213 *
0214 *.... TOP LAYER MAY NOT BE DELZ THICK
0215 *
0216 Y (ISURF) = DEPTH - (HGT (ISURF) * DELZ / 2.0)
0217 *
0218 *.... DESCRIPTION OF WITHDRAWAL DEVICES
0219 *
0220 *.... PORT (AND TOTAL NUMBER THEREOF) OR WEIR
0221 *
0222 READ (IFILE, 620) CHECK, NPORTS
0223 IF (CHECK .NE. XPORT .AND.
0224 & CHECK .NE. XWEIR)
0225 & CALL ERROR (1100 , SUBR, CHECK, XWEIR, XPORT,
0226 & XDUMY3)
0227 *
0228 *.... DETERMINE TYPE OF WITHDRAWAL DEVICE
0229 *
0230 QPORT = CHECK .EQ. XPORT
0231 QWEIR = CHECK .EQ. XWEIR
0232 IF (QPORT) GO TO 220
0233 IF (QWEIR) GO TO 300
0234 220 CONTINUE
0235 *
0236 *.... PORT CHARACTERISTICS
0237 *
0238 *.... PORT VERTICAL DIMENSIONS
0239 *
0240 READ (IFILE, 650) CHECK, (PVDIM (K), K = 1, NPORTS)
0241 IF (CHECK .NE. XVDIM)
0242 & CALL ERROR (1110 , SUBR, CHECK, XVDIM, XDUMY2,
0243 & XDUMY3)
0244 *
0245 *.... PORT HORIZONTAL DIMENSIONS
0246 *
0247 READ (IFILE, 650) CHECK, (PHDIM (K), K = 1, NPORTS)
0248 IF (CHECK .NE. XHDIM)
0249 & CALL ERROR (1120 , SUBR, CHECK, XHDIM, XDUMY2,
0250 & XDUMY3)

```

Instruction Report E-87-2  
July 1992

XREAD

```

0251 *
0252 *.... PORT ELEVATIONS
0253 *
0254 READ (IFILE, 650) CHECK, (PHGT (K), K = 1, NPORTS)
0255 IF (CHECK .NE. XELEV .AND. CHECK .NE. XHEIG .AND.
0256 & CHECK .NE. XDEPT)
0257 & CALL ERROR (1130 , SUBR, CHECK, XDEPT, XHEIG,
0258 & XELEV)
0259 *
0260 *.... CONVERT ELEVATION TO HEIGHT ABOVE BOTTOM
0261 *
0262 IF (CHECK .EQ. XHEIG) GO TO 260
0263 IF (CHECK .EQ. XDEPT) GO TO 240
0264 *
0265 *.... ELEVATION TO HEIGHT
0266 *
0267 DO 230 K = 1, NPORTS
0268 PHGT (K) = PHGT (K) - BOTTOM
0269 230 CONTINUE
0270 GO TO 260
0271 240 CONTINUE
0272 *
0273 *.... DEPTHS TO HEIGHTS
0274 *
0275 DO 250 K = 1, NPORTS
0276 PHGT (K) = SURFACE - PHGT (K) - BOTTOM
0277 250 CONTINUE
0278 260 CONTINUE
0279 *
0280 *.... PORT FLOW RATES
0281 *
0282 READ (IFILE, 650) CHECK, (FLOW (K), K=1, NPORTS)
0283 IF (CHECK .NE. XFLOW)
0284 & CALL ERROR (1140 , SUBR, CHECK, XFLOW, XDUMY2,
0285 & XDUMY3)
0286 *
0287 *.... WITHDRAWAL ANGLE
0288 *
0289 READ (IFILE, 650) CHECK, (WTHETA (K), K=1, NPORTS)
0290 IF (CHECK .NE. XANGL)
0291 & CALL ERROR (1150 , SUBR, CHECK, XANGL, XDUMY2,
0292 & XDUMY3)
0293 IF (NPORTS .EQ. 1) GO TO 290
0294 *
0295 *.... ORDER PORTS FROM BOTTOM TO TOP
0296 *
0297 NP = NPORTS - 1
0298 DO 280 I = 1, NP
0299 K = I + 1
0300 DO 270 J = K, NPORTS

```

XREAD

```

0301 IF (PHGT (I) .LT. PHGT (J)) GO TO 270
0302 *
0303 *.... ASSIGN CHARACTERISTICS OF LOWER SUBSCRIPTED PORTS
0304 * TO DUMMY VARIABLES
0305 *
0306 HGTDUM = PHGT (I)
0307 VDUM = PVDIM (I)
0308 HDUM = PHDIM (I)
0309 FLOWDUM = FLOW (I)
0310 ANGNUM = WTHETA (I)
0311 *
0312 *.... ASSIGN CHARACTERISTICS OF HIGHER SUBSCRIPTED PORTS
0313 * TO LOWER SUBSCRIPT
0314 *
0315 PHGT (I) = PHGT (J)
0316 PVDIM (I) = PVDIM (J)
0317 PHDIM (I) = PHDIM (J)
0318 FLOW (I) = FLOW (J)
0319 WTHETA (I) = WTHETA (J)
0320 *
0321 *.... ASSIGN DUMMY VARIABLE VALUES TO HIGHER SUBSCRIPTED PORT
0322 *
0323 PHGT (J) = HGTDUM
0324 PVDIM (J) = VDUM
0325 PHDIM (J) = HDUM
0326 FLOW (J) = FLOWDUM
0327 WTHETA (J) = ANGNUM
0328 270 CONTINUE
0329 280 CONTINUE
0330 290 CONTINUE
0331 *
0332 *.... CHECK FOR WEIR INPUT
0333 *
0334 READ (IFILE, 620) CHECK
0335 QWEIR = CHECK .EQ. XWEIR
0336 IF (QWEIR) GO TO 300
0337 BACKSPACE IFILE
0338 GO TO 340
0339 300 CONTINUE
0340 *
0341 *.... WEIR CHARACTERISTICS
0342 *
0343 *.... SUBMERGED OR FREE
0344 *
0345 READ (IFILE, 620) CHECK
0346 IF (CHECK .NE. XFREE .AND.
0347 & CHECK .NE. XSUBM)
0348 & CALL ERROR (1160 , SUBR, CHECK, XSUBM, XFREE,
0349 & XDUMY3)
0350 QSUB = CHECK .EQ. XSUBM

```

Instruction Report E-87-2  
July 1992

XREAD

```
0351 IF (QSUB) GO TO 310
0352 *
0353 *.... FREE WEIR COEFFICIENT
0354 *
0355 READ (IFILE, 650) CHECK, COEF
0356 IF (CHECK .NE. XCOEF)
0357 & CALL ERROR (1170 , SUBR, CHECK, XCOEF, XDUMMY2,
0358 & XDUMMY3)
0359 310 CONTINUE
0360 *
0361 *.... WEIR LENGTH
0362 *
0363 READ (IFILE, 650) CHECK, WRLNG
0364 IF (CHECK .NE. XLENG)
0365 & CALL ERROR (1180 , SUBR, CHECK, XLENG, XDUMMY2,
0366 & XDUMMY3)
0367 *
0368 *.... WEIR HEIGHT
0369 *
0370 READ (IFILE, 650) CHECK, WRHGT
0371 IF (CHECK .NE. XELEV .AND. CHECK .NE. XHEIG .AND.
0372 & CHECK .NE. XDEPT)
0373 & CALL ERROR (1200 , SUBR, CHECK, XDEPT, XELEV,
0374 & XHEIG)
0375 *
0376 *.... CONVERT DEPTH OR ELEV TO HEIGHT ABOVE BOTTOM
0377 *
0378 IF (CHECK .EQ. XHEIG) GO TO 330
0379 IF (CHECK .EQ. XDEPT) GO TO 320
0380 *
0381 *.... ELEVATION TO HEIGHT
0382 *
0383 WRHGT = WRHGT - BOTTOM
0384 GO TO 330
0385 320 CONTINUE
0386 *
0387 *.... DEPTH TO HEIGHT
0388 *
0389 WRHGT = SURFACE - WRHGT - BOTTOM
0390 330 CONTINUE
0391 *
0392 *.... FLOW RATE OVER WEIR
0393 *
0394 READ (IFILE, 650) CHECK, WRFLOW
0395 IF (CHECK .NE. XFLOW)
0396 & CALL ERROR (1210 , SUBR, CHECK, XFLOW, XDUMMY2,
0397 & XDUMMY3)
0398 340 CONTINUE
0399 *
0400 *.... TURBINE VENTING OR CONDUIT AERATION
```

XREAD

```

0401 *
0402 READ(IFILE, 610) CHECK
0403 QVENT = CHECK .EQ. XTURB
0404 QAERA = CHECK .EQ. XGATE
0405 IF(.NOT. QVENT .AND. .NOT. QAERA) BACKSPACE IFILE
0406 *
0407 *.... TAILWATER FUNCTION OR SINGLE ELEVATION.
0408 * NEEDED WHEN QAERA =.TRUE.
0409 *
0410 IF (.NOT. QAERA) GO TO 345
0411 READ (IFILE, 635) CHECK1, CHECK2, TWEL
0412 IF (CHECK1 .NE. XTAIL)
0413 & CALL ERROR(1215 , SUBR, CHECK1, XTAIL, XDUMMY2,
0414 & XDUMMY3)
0415 QTWFUN = CHECK2 .EQ. XFUNC
0416 345 CONTINUE
0417 *
0418 *.... INFORMATION FOR DENSITY OR TEMP PROFILE INCLUDING
0419 * NUMBER OF DATA
0420 *
0421 READ (IFILE, 640) CHECK1, CHECK2, NUMD
0422 IF (CHECK1 .NE. XNUMB)
0423 & CALL ERROR (1220 , SUBR, CHECK1, XNUMB, XDUMMY2,
0424 & XDUMMY3)
0425 IF(CHECK2 .NE. XDENS .AND. CHECK2 .NE. XTEMP)
0426 & CALL ERROR (1225 , SUBR, CHECK2, XDENS, XTEMP,
0427 & XDUMMY3)
0428 *
0429 QDEN = CHECK2 .EQ. XDENS
0430 IF (QDEN) GO TO 350
0431 NUMT = NUMD
0432 GO TO 420
0433 350 CONTINUE
0434 *
0435 *.... DENSITY
0436 *
0437 IF (QTAB1) GO TO 360
0438 *
0439 *.... ELEVATION AND DENSITY VALUES LISTED IN SEPERATE TABLES
0440 *
0441 READ (IFILE, 610) CHECK
0442 *
0443 *.... ELEVATIONS
0444 *
0445 IF (CHECK .NE. XELEV .AND. CHECK .NE. XHEIG .AND.
0446 & CHECK .NE. XDEPT)
0447 & CALL ERROR (1230 , SUBR, CHECK, XDEPT, XHEIG,
0448 & XELEV)
0449 READ (IFILE, 660) (YD (M), M = 1, NUMD)
0450 *

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Instruction Report E-87-2  
July 1992

XREAD

```

0451 *.... DENSITIES
0452 *
0453 READ (IFILE, 620) CHECK
0454 IF (CHECK .NE. XDENS)
0455 & CALL ERROR (1240 , SUBR, CHECK, XDENS, IFILE)
0456 &
0457 READ (IFILE, 660) (DEN (M), M = 1, NUMD)
0458 GO TO 370
0459 360 CONTINUE
0460 *
0461 *.... ELEVATION AND DENSITY VALUES LISTED IN ONE TABLE
0462 *
0463 READ (IFILE, 670) CHECK1, CHECK2
0464 IF (CHECK1 .NE. XDEPT .AND. CHECK1 .NE. XELEV)
0465 & .AND. CHECK1 .NE. XELEV)
0466 & CALL ERROR (1250 , SUBR, CHECK1, XDEPT, XELEV, IFILE)
0467 &
0468 IF (CHECK2 .NE. XDENS)
0469 & CALL ERROR (1260 , SUBR, CHECK2, XDENS, IFILE)
0470 &
0471 READ (IFILE, 680) (YD (M), M = 1, NUMD)
0472 CHECK = CHECK1
0473 370 CONTINUE
0474 *
0475 *.... CONVERT DEPTH OR ELEVATION TO HEIGHT
0476 *
0477 IF (CHECK .EQ. XHEIGHT)
0478 IF (CHECK .EQ. XDEPT)
0479 *
0480 *.... ELEVATION TO HEIGHT
0481 *
0482 DO 380 M = 1, NUMD
0483 YD (M) = YD (M) + XHEIGHT
0484 380 CONTINUE
0485 GO TO 410
0486 390 CONTINUE
0487 *
0488 *.... DEPTH TO HEIGHT
0489 *
0490 DO 400 M = 1, NUMD
0491 YD (M) = YD (M) - XDEPTH
0492 400 CONTINUE
0493 410 CONTINUE
0494 *
0495 *.... GENERATE NAME
0496 *
0497 CALL INTER
0498 *
0499 *.... CHECK FOR NAME
0500 * NAME = NAME

```

AD-A181 125

ENVIRONMENTAL AND WATER QUALITY OPERATIONAL STUDIES

373

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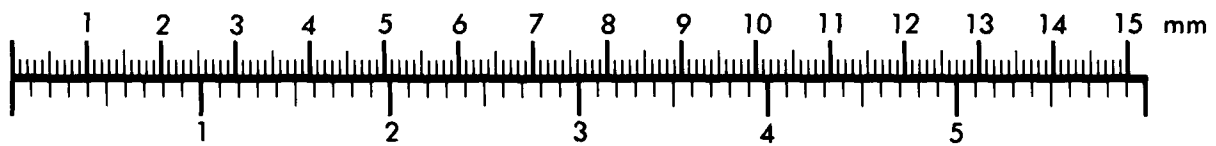
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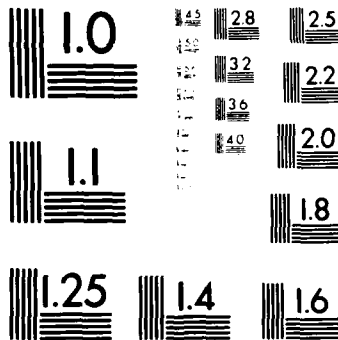
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XREAD

```

0501 *
0502 READ (IFILE, 700) CHECK, NUMT
0503 IF (CHECK .NE. XNUMB .AND. CHECK .NE. XQUAL .AND.
0504 & CHECK .NE. XSTOP)
0505 & CALL ERROR (1270 , SUBR, CHECK, XNUMB, XQUAL,
0506 & XSTOP)
0507 IF (CHECK .EQ. XSTOP) RETURN
0508 IF (CHECK .EQ. XQUAL) GO TO 490
0509 *
0510 *.... TEMPERATURE
0511 *
0512 420 CONTINUE
0513 *
0514 *.... FAHRENHEIT OR CENTIGRADE
0515 *
0516 READ (IFILE, 690) CHECK, UNITS
0517 IF (CHECK .NE. XTEMP .AND. CHECK .NE. XSTOP)
0518 & CALL ERROR (1280 , SUBR, CHECK, XTEMP, XSTOP,
0519 & XDUMY3)
0520 *
0521 IF (CHECK .EQ. XSTOP) RETURN
0522 IF (UNITS .NE. XFAHR .AND. UNITS .NE. XCENT)
0523 & CALL ERROR (1290 , SUBR, UNITS, XFAHR, XCENT,
0524 & XDUMY3)
0525 *
0526 QCENT = UNITS .EQ. XCENT
0527 QTEMP = .TRUE.
0528 IF (QTAB1) GO TO 430
0529 *
0530 *.... ELEVATION AND TEMPERATURE LISTED IN SEPERATE TABLES
0531 *
0532 READ (IFILE, 610) CHECK
0533 *
0534 *.... ELEVATION TABLE
0535 *
0536 IF (CHECK .NE. XELEV .AND. CHECK .NE. XHEIG .AND.
0537 & CHECK .NE. XDEPT)
0538 & CALL ERROR (1300 , SUBR, CHECK, XHEIG, XELEV,
0539 & XDEPT)
0540 READ (IFILE, 660) (YT (M), M = 1, NUMT)
0541 *
0542 *.... TEMPERATURE TABLE
0543 *
0544 READ (IFILE, 610) CHECK
0545 IF (CHECK .NE. XTEMP)
0546 & CALL ERROR (1310 , SUBR, CHECK, XTEMP, XDUMY2,
0547 & XDUMY3)
0548 READ (IFILE, 660) (TEMP (M), M = 1, NUMT)
0549 GO TO 440
0550 430 CONTINUE

```

Instruction Report E-87-2  
July 1992

XREAD

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0551 *
0552 *.... ELEVATION AND TEMP LISTED IN ONE TABLE
0553 *
0554 READ (IFILE, 670) CHECK1, CHECK2
0555 IF (CHECK1 .NE. XELEV .AND. CHECK1 .NE. XHEIG
0556 & .AND. CHECK1 .NE. XDEPT)
0557 & CALL ERROR (1320 , SUBR, CHECK1, XDEPT, XELEV,
0558 & XHEIG)
0559 IF (CHECK2 .NE. XTEMP)
0560 & CALL ERROR (1330 , SUBR, CHECK2, XTEMP, XDUMY2,
0561 & XDUMY3)
0562 READ (IFILE, 680) (YT (M), TEMP (M), M = 1, NUMT)
0563 CHECK = CHECK1
0564 440 CONTINUE
0565 *
0566 *.... CONVERT ELEVATION OR DEPTH TO HEIGHT ABOVE BOTTOM
0567 *
0568 IF (CHECK .EQ. XHEIG) GO TO 480
0569 IF (CHECK .EQ. XDEPT) GO TO 460
0570 *
0571 *.... ELEVATION TO HEIGHT
0572 *
0573 DO 450 M = 1, NUMT
0574 YT (M) = YT (M) - BOTTOM
0575 450 CONTINUE
0576 *
0577 GO TO 480
0578 460 CONTINUE
0579 *
0580 *.... DEPTH TO HEIGHT
0581 *
0582 DO 470 M = 1, NUMT
0583 YT (M) = SURFACE - YT (M) - BOTTOM
0584 470 CONTINUE
0585 480 CONTINUE
0586 *
0587 *.... GENERATE COMPUTATIONAL PROFILE
0588 *
0589 CALL INTERP (TEMP, YT, NUMT)
0590 *
0591 GO TO 500
0592 *
0593 *.... QUALITIES
0594 *
0595 490 CONTINUE
0596 BACKSPACE IFILE
0597 500 CONTINUE
0598 *
0599 *.... CHECK FOR QUALITY PROFILE (AND NUMBER OF DATA)
0600 * OR A STOP COMMAND
```

XREAD

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0601 *
0602 READ (IFILE, 620) CHECK, NQUAL
0603 QQUAL = CHECK .EQ. XQUAL
0604 IF (CHECK .NE. XQUAL .AND.
0605 & CHECK .NE. XSTOP)
0606 & CALL ERROR (1340 , SUBR, CHECK, XQUAL, XSTOP,
0607 & XDUMMY3)
0608 IF (CHECK .EQ. XSTOP) RETURN
0609 DO 590 I = 1, NQUAL
0610 READ (IFILE, 710) CHECK, (NAMEQ (NM, I),
0611 & NM = 1, 5), NUMQ (I)
0612 IF (CHECK .NE. XNUMB)
0613 & CALL ERROR (1350 , SUBR, CHECK, XNUMB, XDUMMY2,
0614 & XDUMMY3)
0615 *
0616 *.... CHECK THAT THE FIRST QUALITY PROFILE IS DISSOLVED OXYGEN
0617 * WHEN AERATE OR VENTING SUBROUTINES ARE TO BE USED
0618 *
0619 IF(QVENT .OR. QAERA .AND. NAMEQ (1, 1) .NE. XDISS)
0620 & CALL ERROR (1345 , SUBR, XDUMMY, XDUMMY1, XDUMMY2,
0621 & XDUMMY3)
0622 NUMBER = NUMQ (I)
0623 IF (QTAB1) GO TO 510
0624 *
0625 *.... ELEVATION AND QUALITY LISTED IN SEPERATE TABLES
0626 *
0627 READ (IFILE, 610) CHECK
0628 *
0629 *.... ELEVATION TABLE
0630 *
0631 IF (CHECK .NE. XELEV .AND. CHECK .NE. XHEIG .AND.
0632 & CHECK .NE. XDEPT)
0633 & CALL ERROR (1360, SUBR, CHECK, XDEPT, XHEIG,
0634 & XELEV)
0635 READ (IFILE, 660) (YQ (I , M), M = 1, NUMBER)
0636 *
0637 *.... QUALITY PARAMETERS
0638 *
0639 READ (IFILE, 610) CHECK
0640 READ (IFILE, 660) (QUAL (I , M), M = 1, NUMBER)
0641 GO TO 520
0642 510 CONTINUE
0643 *
0644 *.... ELEVATION AND QUALITY LISTED IN ONE TABLE
0645 *
0646 READ (IFILE, 670) CHECK
0647 IF (CHECK .NE. XELEV .AND. CHECK .NE. XHEIG
0648 & .AND. CHECK .NE. XDEPT)
0649 & CALL ERROR (1370 , SUBR, CHECK, XDEPT, XHEIG,
0650 & XELEV)

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Instruction Report E-87-2  
July 1992

XREAD

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0651 READ (IFILE, 680) (YQ (I , M), QUAL (I , M),
0652 & M - 1, NUMBER)
0653
0654 520 CONTINUE
0655 *
0656 *.... CONVERT ELEVATION OR DEPTH TO HEIGHT ABOVE THE BOTTOM
0657 *
0658 IF (CHECK .EQ. XHEIG) GO TO 560
0659 IF (CHECK .EQ. XDEPT) GO TO 540
0660 *
0661 *.... ELEVATION TO HEIGHT
0662 *
0663 DO 530 M = 1, NUMBER
0664 YQ (I , M) = YQ (I , M) - BOTTOM
0665 530 CONTINUE
0666 GO TO 560
0667 540 CONTINUE
0668 *
0669 *.... DEPTH TO HEIGHT
0670 *
0671 DO 550 M = 1, NUMBER
0672 YQ (I , M) = SURFACE - YQ (I , M) - BOTTOM
0673 550 CONTINUE
0674 560 CONTINUE
0675 *
0676 *.... ASSIGN QUALITY VALUES TO DUMMY VARIABLES TO BE PASSED
0677 * TO ROUTINE INTERP
0678 *
0679 NQ = NUMQ (I)
0680 DO 570 K = 1 , NUMBER
0681 DUMQUAL (K) = QUAL (I , K)
0682 DUMYQ (K) = YQ (I , K)
0683 570 CONTINUE
0684 *
0685 *.... GENERATE COMPUTATIONAL PROFILE
0686 *
0687 CALL INTERP (DUMQUAL, DUMYQ, NQ)
0688 *
0689 *.... ASSIGN ROUTINE INTERP OUTPUT TO ARRAY
0690 *
0691 DO 580 K = 1, ISURF
0692 QUAL (I , K) = DUMQUAL (K)
0693 580 CONTINUE
0694 590 CONTINUE
0695 *
0696 *.... STOP COMMAND
0697 *
0698 READ (IFILE, 610) CHECK
0699 IF (CHECK .NE. XSTOP)
0700 & CALL ERROR (1380 , SUBR, CHECK, XSTOP, XDUMY2,

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XREAD

```
0701 & XDUMMY3)
0702 600 FORMAT (1H1)
0703 610 FORMAT (20A4)
0704 620 FORMAT (A4, 6X, 14I5)
0705 630 FORMAT (10X, I6, 7X, 3H***, 20A4)
0706 635 FORMAT(A4, 6X, A4, 6X, 6F10.0)
0707 640 FORMAT (A4, 6X, A4, 6X, 12I5)
0708 650 FORMAT (A4, 6X, (7F10.0))
0709 660 FORMAT (8F10.0)
0710 670 FORMAT (A4, 6X, A4)
0711 680 FORMAT (2F10.0)
0712 690 FORMAT (A4, 16X, A4)
0713 700 FORMAT (A4, 16X, 12I5)
0714 710 FORMAT (A4, 6X, 5A4, I5)
0715 RETURN
0716 END
```

**END  
FILMED**

**DATE:**

*10-92*

**DTIC**